TT
180
G7

WOOD-WORKING FOR AMATEUR CRAFTSMEN

GRIFFITH

POPULAR MECHANICS HANDBOOKS

Class TT180
Book G7
Copyright No.

COPYRIGHT DEPOSIT.

WOOD-WORKING

FOR

AMATEUR CRAFTSMEN

BY

IRA S. GRIFFITH, A. B.

Supervisor of Manual Training, Oak Park, Ill.; Instructor in Wood-Work and Methods, Bradley Polytechnic Institute Summer School; Editor Illinois Manual Arts Association; Chairman Editorial Board, Western Drawing and Manual Training Association.

POPULAR MECHANICS HANDBOOKS

CHICAGO
POPULAR MECHANICS CO.

Copyright, 1911
By
H. H. WINDSOR

$0.25

©Cl.A286785

11-11196

aug. Mar 10, 1911.

THIS book is one of the series of handbooks on industrial subjects being published by the Popular Mechanics Company. Like the Magazine, these books are "written so you can understand it," and are intended to furnish information on mechanical subjects at a price within the reach of all.

The texts and illustrations have been prepared expressly for this Handbook Series, by experts; are up-to-date, and have been revised by the editor of Popular Mechanics.

CONTENTS

		PAGE
CHAPTER	I, Making Out a Stock Bill.	7
CHAPTER	II, Laying Out Rough Stock.	11
CHAPTER	III, Hand Saws	13
CHAPTER	IV, Sawing with Hand Saws.	17
CHAPTER	V, Planes: How to Set and Adjust the Irons.....	20
CHAPTER	VI, Squaring Up Mill-Planed Stock	26
CHAPTER	VII, Squaring Up Mill-Planed Stock (continued).....	33
CHAPTER	VIII, Squaring Up Rough Stock	39
CHAPTER	IX, Whetting Plane Irons and Chisels	45
CHAPTER	X, Grinding Plane Irons and Chisels	50
CHAPTER	XI, Making a Bird Box.....	55
CHAPTER	XII, Making a Taboret.....	63
CHAPTER	XIII, How to Make an Umbrella Stand.....	74
CHAPTER	XIV, Making a Magazine Stand	84
CHAPTER	XV, Making a Table	93
CHAPTER	XVI, Making a Cabinet 103	

WOOD-WORKING FOR AMATEUR CRAFTSMEN

CHAPTER I

MAKING OUT A STOCK BILL

THE first thing a beginner must learn to do when he takes a drawing from which he is to make a piece of woodwork, is to prepare a stock bill of materials that can be given to the lumberman to fill. Whether the worker gets what he wants or not will depend greatly upon the specifications he gives the dealer, whether they are intelligible or not, and whether they allow one and only one interpretation.

Three practices are common in preparing lumber for use: To sell it to the workman in the rough, just as it comes from the sawmill; to machine-plane the pieces to thicknesses and widths such as the finished pieces demand, so that only the lengths require the attention of the worker—aside from the making of the joints; and to mill-plane the stock on two surfaces to stock thicknesses, but allowing the lengths and widths to remain as in rough stock.

The first is cheapest in first cost; the second is the most expensive because of the frequent changes in setting the planing machine to the different sizes. The third is most common, except where there are to be a great number of pieces of a given size, because it utilizes hand work and machine work to the best advantage.

TICKET NUMBER	No. OF FEET	No. OF PIECES	SIZE	LENGTH	DESCRIPTION	PRICE
	48	1	6X8	1-	YELLOW PINE 5-4-5	30 1 44
		16	M		EX X-A-A WHITE CEDAR SHINGLES	3 25 52
	406		1X6	14	#2 WHITE PINE FLOORING	26 10 50
						63 94

Form of Stock Bill

Lumber Terms—Length always extends parallel to the grain of the wood—the way the wood splits easiest. Other terms are as indicated in Fig. 1.

The unit of measurement is the board foot. This is 1 by 12 by 12 in. Prices are usually based upon the 1000 ft. If a board is less than 1 in. thick, it is customary to figure it at surface measure. The price per foot is reduced correspondingly, however, so that no advantage is taken of the purchaser.

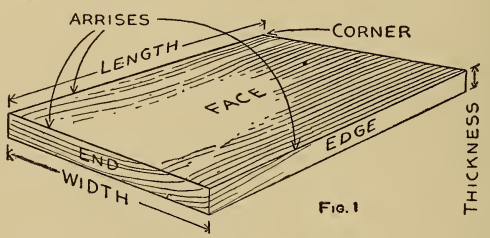


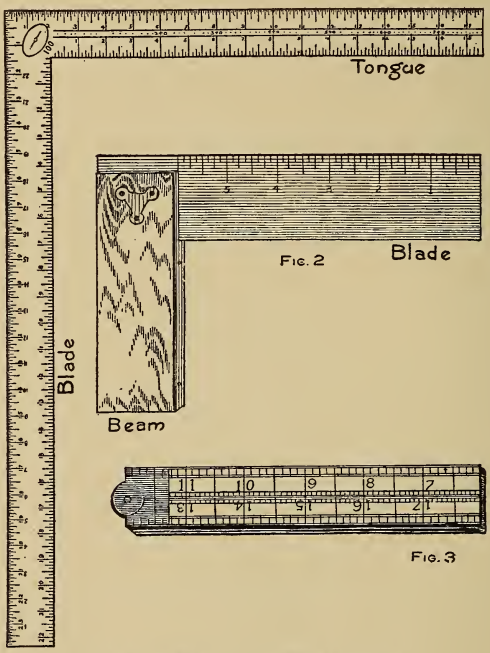
FIG. 1

Board Surfaces Named

Lumber is graded at the yards according to lumbermen's standards. Clear lumber is free from knots, sap, wind, shakes and other imperfections. Shingles are sold by the thousand and are packed in bunches; laths, in bundles. Mouldings are sold by the running or lineal measure, the price being based on the 1000 ft.

The abbreviations for lumber that is to be sized, surfaced or machine-planed on two or four sides are S-2-S and S-4-S, respectively.

For especially seasoned stock, the letters K D (kiln dried) are added to the description.



Steel Square, Try-Square and Rule

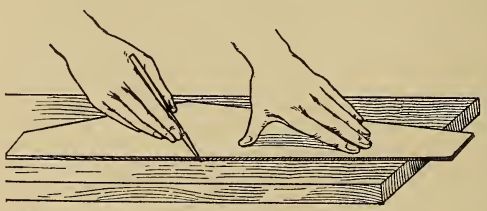


Fig 4

Making a Straightedge Line

CHAPTER II

LAYING OUT ROUGH STOCK

THE tools needed for this are the rule, try-square or steel square, a straightedge and a pencil. Figure 2 shows the try-square and steel or framing square, and gives the names of the parts. The rule used may be the single-piece rule or the folding 2-ft.

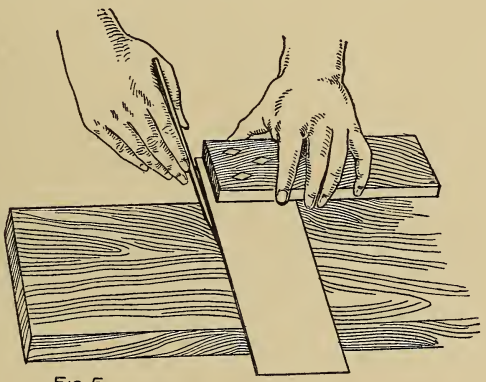


FIG. 5

Squaring Across a Board

rule, such as carpenters use (Fig. 3). A straightedge is anything which has one of its edges straight.

Directions: Measure off and mark the length of the piece required; measure off near the end the width wanted; at what is to become the other end of the piece, mark off the width as before. With the straightedge, connect these points and draw a line through

them (Fig. 4). With the try-square or steel square draw a line to limit the length (Fig. 5).

A second way to lay out the piece, where the first edge is fairly straight, is to thumb-gauge for width.

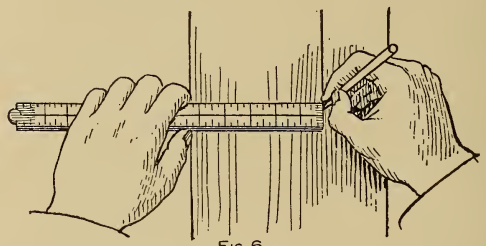


FIG. 6

"Thumb" Gauging

This is done as shown in Fig. 6. The pencil is held against the end of the rule and the whole is pulled toward the worker. The thumbnail of the left hand held on the rule at the desired point acts as a gauge head.

CHAPTER III

HAND SAWS

HAND saws are of two kinds—rip and crosscut. The first is for sawing along the grain, the direction in which wood splits easiest, the other for sawing across the grain. The necessity for having a saw for each direction of cutting with reference to the grain is clearly shown in Fig. 7 The ripsaw is really nothing more than a lot of little narrow chisels so arranged that they cut, one after the other, in rapid succession, the cutting edge, like that of the chisel, being on the

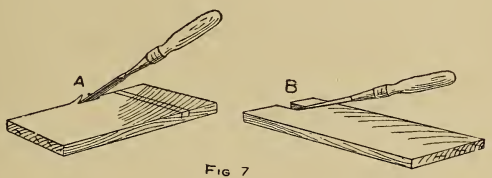


FIG 7

The Way Ripsaw Teeth Cut

front of the teeth. To cut across the grain with a ripsaw would be to split the wood as in A, Fig. 7. Cutting with the grain is shown in B. The teeth of the crosscut saw are so sharpened, that the cutting edges are on the sides of the teeth instead of in front. Figure 8 shows the shape of both rip and crosscut saw teeth.

Both of these saws are sharpened with exactly the same tools, the differences in the teeth being due to the difference in angle at which the file is held in the process.

Sharpening a saw is considered a difficult thing to learn, so difficult that it is not necessary to go into a lengthy description for beginners. It may be worth while, however, to state the steps that are taken in

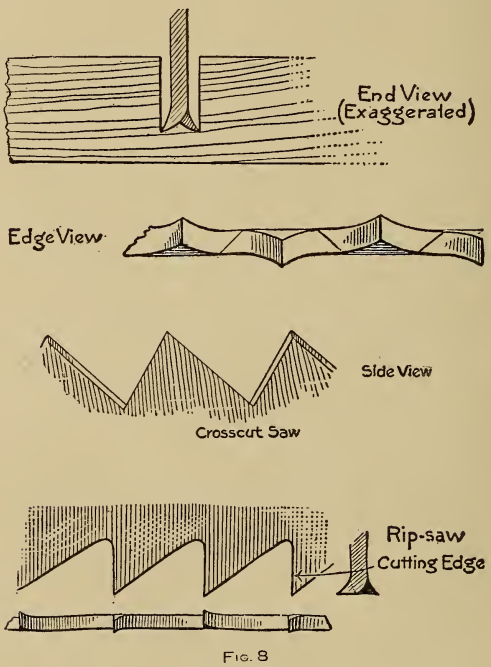


FIG. 8

Setting Saws

putting a saw in order. The beginner ought to know how the tools are sharpened, even if he must attain more experience before attempting to sharpen them. First, the teeth are jointed. This is done by running

a flat file along the length of the saw so as to cut down any teeth that project farther than others (Fig. 9). Second, the teeth are filed, a three-cornered file being

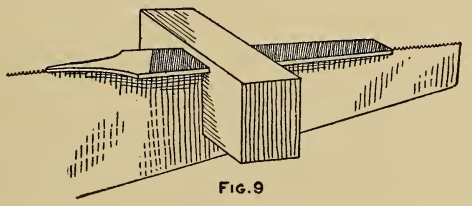


FIG. 9

Jointing the Teeth

FIG. 10

Filing a Ripsaw

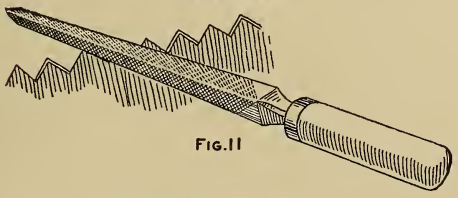


FIG. 11

Filing a Crosscut Saw

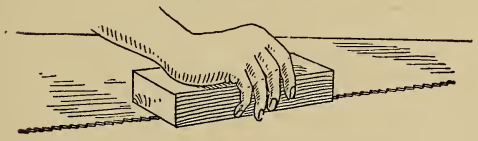


FIG. 12

Jointing the Sides of the Teeth

used, the kind of saw determining the angle or angles at which it is held with reference to the side of the saw. The ripsaw is filed straight across (Fig. 10).

The crosscut is filed as in Fig. 11. After the filing, the teeth are side jointed. This is done by running an oil-stone over the sides of the saw and teeth, as in Fig. 12. This will make the sides of the teeth cut a smooth kerf.

If the saw, before filing, had a tendency to stick in the wood, it should have its teeth set before the top jointing. Figure 13 shows a modern saw-set. These

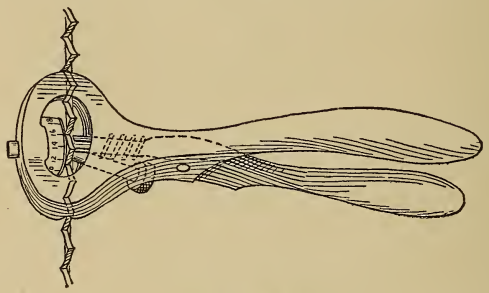


Fig. 13 — Saw Set

sets are adjustable so that the teeth may be bent much or little, as the condition of the wood necessitates. No more set than is necessary is a good rule. Moving the handles together shoves the plunger forward. This bends the tooth outward from the side of the saw. Every other tooth is set; the saw is then reversed and the remaining teeth are set from the second side.

CHAPTER IV

SAWING WITH HAND SAWS

IN using the hand saws, the most advantageous position is obtained by placing the board which is to be sawed upon a pair of "horses" or trestles.

Whether ripping—cutting parallel to the grain—or crosscutting, the manner of starting the cut or kerf and guiding the saw throughout the operation is the same.

Figure 14 shows clearly the position of the hands when starting the kerf. The index finger of the right hand extends along the side of the handle to assist in guiding the saw. The thumb of the left hand rests upon the board at the place where the cut is to be made. With the right hand the saw blade is pressed lightly against this thumb and thus assists in setting the saw at the desired point.

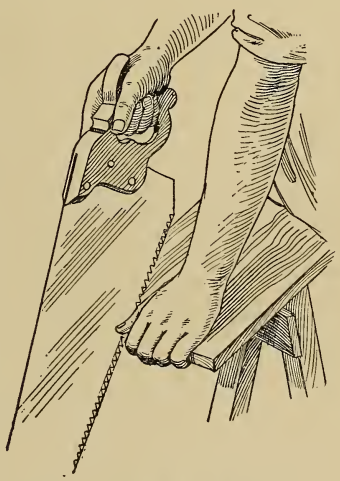


Fig. 14—Guiding the Saw with Left Thumb

Begin with short, light, easy strokes, holding up on the saw so that it shall take small "bites" at first.

Fig. 15—Correct Angle of Saw

held at an angle of about 50 or 60 deg. with the board. Stand so as to give the arm free and easy movement, keeping the eye, hand and saw in one and the same plane (Fig. 16).

If the saw should fail to follow the line, a slight and continued twist with the hand that holds the saw handle, as the sawing proceeds, will soon cause the cutting edge to work its way back to the line. This twisting must be carefully done or the blade will bind and kink.

When nearing the finish, Gradually increase the length of stroke until the full arm stroke is obtained. Avoid short, jerky strokes and undue pressure. Time is lost thereby, the saw cannot be properly guided, and the work is made unnecessarily laborious. Figs. 15 and 16 show the proper position to assume. The saw will cut best when

Fig. 16—Saw, Wrist and Elbow in One Plane

ish of a cut, lessen the length of the stroke and hold up on the saw so that little weight rests upon the wood; at the same time, if crosscutting, reach over the saw and take hold of the overhanging piece (Fig. 17).

Where it is desired to cut out a small piece from a long board, always ripsaw first, then crosscut to meet this kerf, leaving on the board all but just what is wanted for present use. There are two reasons for this: first, economy; second, there is always danger of splitting off the piece when making the second cut, if the crosscutting is done first.

Fig. 17 — Holding Overhanging Piece

CHAPTER V

PLANES: HOW TO SET AND ADJUST THE IRONS

AMONG the various planes used by wood-workers are the following: block plane, smooth plane, jack plane, jointer and a special plane known as a combination plane. Not all of these planes are absolutely necessary for simple work such as a beginner would do, but they are desirable. The smooth plane, jack plane and jointer differ only in their length, width of cutter or plane iron, and in the manner of shaping the cutting edge of the plane iron.

The jack plane, Fig. 18, is used for planing off rough surfaces or where it is desired to take off a large quantity of wood quickly. Since it is not expected to leave the surface smooth, this being done by means of another plane, the plane iron of the jack plane is ground rounding as shown in Fig. 18, B, this form of iron being better adapted for "roughing off."

The smooth plane, Fig. 19, is shorter than the jack plane. Since it is used merely, as its name implies, for smoothing off surfaces that have previously been straightened, or surfaces where straightening is not essential, the short length is an advantage rather than a disadvantage. Its plane iron is ground straight across with the corners very slightly rounded (Fig. 19, B).

For planing long edges straight, the jointer, Fig. 20, is used. Because of its great length it makes edge planing much easier than when the shorter planes are used. On account of its length, the high places must

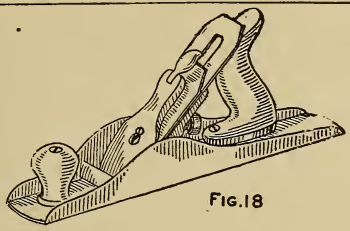


FIG. 18

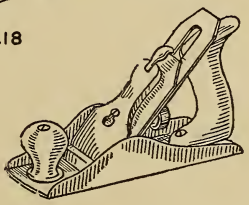


FIG. 19

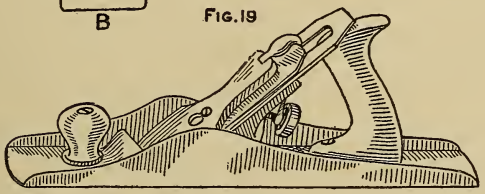


FIG. 20

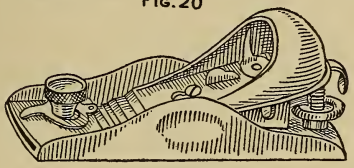


FIG. 21

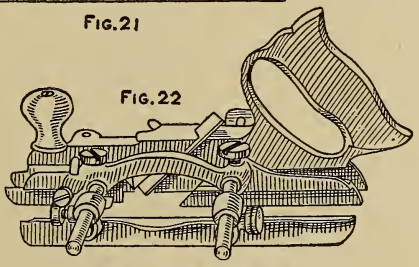


FIG. 22

Different Kinds of Planes

be cut off before the plane iron can touch the low places. Its iron is sharpened like that of the smooth plane—straight across.

The block plane, Fig. 21, is used for planing the ends of pieces of wood; for this reason no cap iron is necessary to break the shaving, there being none, only sawdust. It also differs from the other planes in that the bevel of the plane iron is turned up instead of down The block plane's chief advantage over the other planes for end planing lies in its being small enough to be operated with one hand, leaving the other free to hold the board.

The combination plane, Fig. 22, is used in making grooves, rebates, etc. By an exchange of cutters it may be made to take the placé of a great variety of special planes.

Figure 23 shows a section of a modern plane and gives the names of the more important parts. From this it will be seen that the principal parts consist of the cap, the cap iron which breaks and bends the shaving (Fig. 24) so that the wood may not be torn up, the plane iron for cutting the wood and the frog to which these parts are fastened.

Figure 25 shows the relative positions of plane iron and cap iron. The cutting edge of the plane iron should extend about $\frac{1}{16}$ in. below the edge of the cap iron for ordinary work. For fine work, the distance between the edges should be less. The cap iron and plane iron must be firmly fastened together, the cap being used to turn the stout screw, unless a screwdriver is at hand; otherwise, a few strokes will have pushed the iron back into the mouth of the plane.

After these parts are securely fastened together, put them on the frog, plane iron down and cap iron up, making sure the plane iron rests flat on the frog with

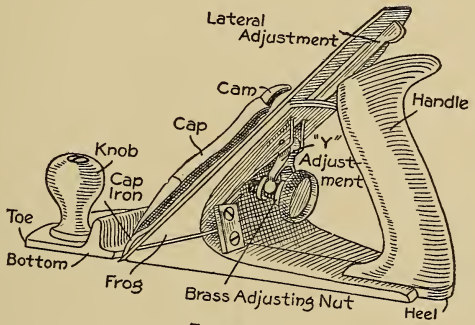


FIG. 23

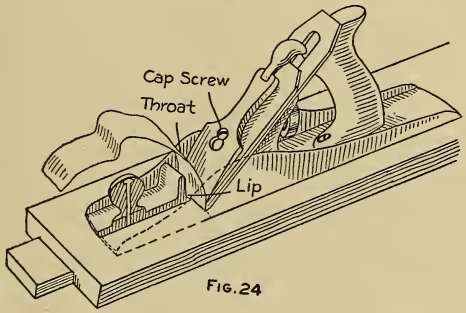


FIG. 24

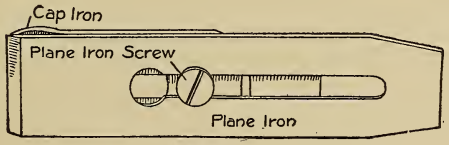


FIG. 25

Plane Parts

the Y-adjustment in the slot in the cap iron made for it. Next, place the cap in position and push down the cam. Should this cam work loosely and the plane iron and cap iron not be held firmly, adjust the cap screw. Ordinarily this screw when once adjusted needs no

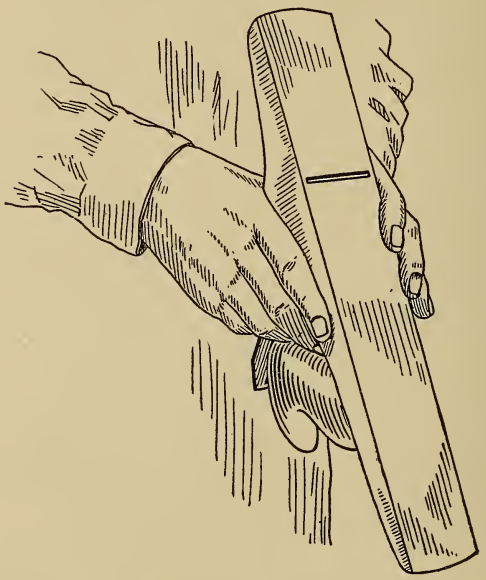


Fig. 26 — Adjusting the Plane Iron

attention. Should the cam work too hard, make sure the plane iron is flat on the frog before releasing the cap screw.

To adjust the blade or plane iron, hold it as shown in Fig. 26, turning the plane toward the light. Sight

along the bottom, turning the adjusting nut until the blade will project very slightly, not much more than the thickness of drawing paper. The most common error beginners make in learning to use the plane is setting the plane iron too far out of the mouth of the plane. Move the lateral adjusting lever to one side or the other until the plane iron projects the same amount on each side.

CHAPTER VI

SQUARING UP MILL-PLANED STOCK

PRACTICALLY every lumber yard carries in stock lumber that has been mill-planed on two surfaces to stock thicknesses. Wood-workers can specify the thickness wanted for the work they have in hand and thus avoid much of the drudgery necessitated by planing up stock entirely in the rough as it comes from the sawmill.

The first broad surface and the first edge planed have a peculiar use and definite names. The first surface is called face side or often working face. The first edge is called face edge or frequently joint edge. These are marked to distinguish them from the others, as shown in Fig. 27. They are the only ones marked. From these two faces, and these only, all testing is to be done, the beam of the try-square and the head of the gauge being held against one or the other.

In selecting these faces, the better broad surface and the better edge are taken, if the object is to consist of but one piece. If it is to consist of several parts, such as a table or a chair, the poorer surfaces are to be selected for faces. Where several parts are to be joined, the faces are turned "in" because, being the first prepared, they are more accurate than the others. Any inaccuracies in the first surfaces will appear in the others, since they are worked from the first surfaces. Some inaccuracies may be present in the second surfaces which are not present in the first set. For this reason the face sides when joined together are more

likely to make close-fitting joints than the others. Frequently there is little choice of surfaces. Generally, however, slight streaks of sapwood, smoothness of surface, etc., will be the determining factors.

Fig. 27—Face Marks

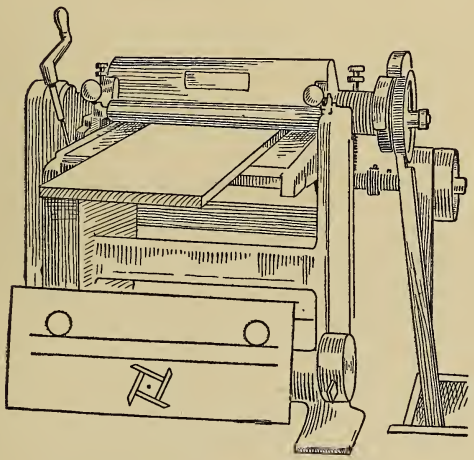


Fig. 28—Surfacing a Board

Planing First Surface

Should the piece not be of equal width and thickness, select the broad surface which is desired for face side. With the smooth plane remove the mill-marks

from it. Mill-marks are the little ridges and hollows which extend across every piece of mill-planed lumber. In mill-planing, a series of knives, two and sometimes four, are caused to revolve very rapidly above or below the board, sometimes both above and below, as it passes through the planer, shown in Fig. 28. If the knives are properly set, revolve very rapidly, and the board is not made to travel over the planer bed too rapidly, these marks are hardly noticeable. They must be removed with the hand plane, however, from any lumber that is to be used for interior finish or cabinet work. If they are not removed, the filler or stain will tend to "bring out" and emphasize every hollow and thus give the wood an ugly, streaked appearance.

Fig. 29—Starting the Plane and Finishing the Stroke

Since it is difficult to tell where the smooth plane has or has not cut in removing these marks, it is a good plan to make a series of light pencil lines across the board at frequent space intervals before beginning to plane. When these have been removed the mill-marks will have been removed, too.

In planing, press firmly on the knob in starting and upon the handle in stopping the stroke (Fig. 29), or the ends of the board will be lowered too much. If the board is a long one, it will be necessary to start

and stop some of the strokes in its middle. That no marks may show where this takes place, the shavings must be "feathered." This is done by lowering the toe of the plane first in starting and by raising the heel

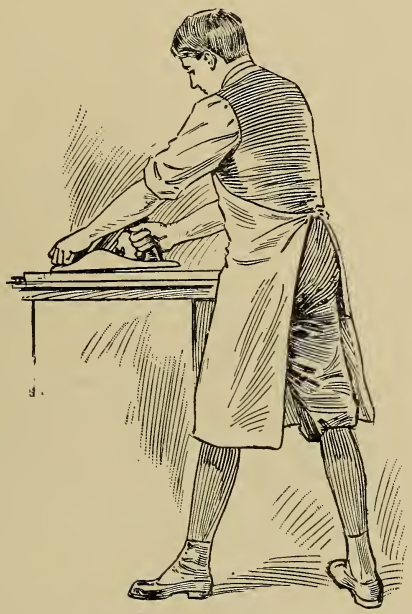


Fig. 30 — Feathering a Shaving

of the plane gradually as the completion of the stroke is neared. This is shown in Fig. 30.

A board will very often become warped or dished after having been planed level at the mill. The nature of the work in which it is to be used will determine whether or not this first surface is to be leveled or merely smoothed. If dished much, and the work

require a level surface, a new piece or a thicker piece will be needed. In many cases the dish will "nail out" so that the first surface needs only smoothing. This is illustrated in Fig. 31, where a bottom board is being

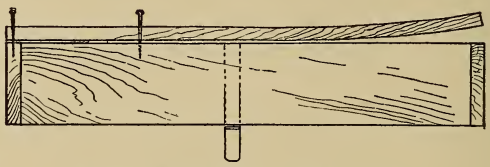


Fig. 31—Nailing Out "Dished" Board

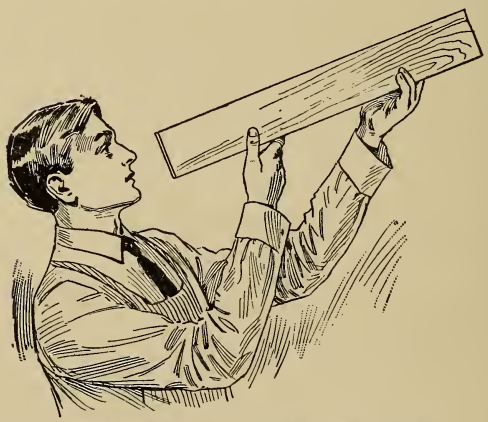


Fig. 32—Sighting for Straightness of Edge

nailed to the side of a box. When this surface has been sufficiently smoothed, mark it for a face side.

Planing First Edge

Select and prepare one of the edges for a face edge. Place the piece against the bench stop or in the vise.

The jointer is usually used for edge planing after the jack plane has been used to remove the roughness. After a few strokes, hold the board toward the light, close one eye and look along the edge (Fig. 32), to see

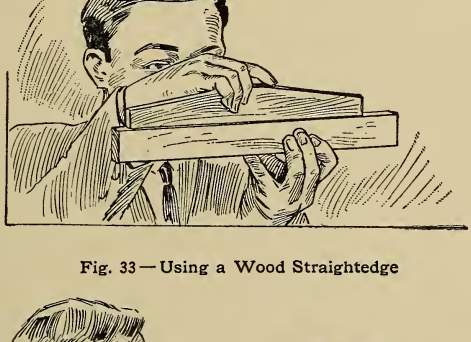


Fig. 33—Using a Wood Straightedge

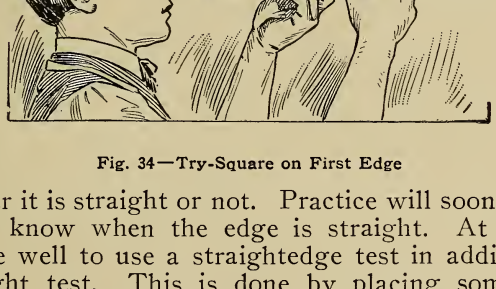


Fig. 34—Try-Square on First Edge

whether it is straight or not. Practice will soon enable one to know when the edge is straight. At first it may be well to use a straightedge test in addition to the sight test. This is done by placing something having a straight edge as shown in Fig. 33, holding the board and straightedge between the eye and the light so that any unevenness may show plainly.

The second test is to place the try-square as in Fig. 34. Hold the beam firmly against the face side and make the test at a sufficient number of places along the edge to show its true condition. Should light show under the blade, note where it is, place the piece in the vise again and move the plane over to the side opposite that at which the light appeared, Fig. 35. Take off no more shavings in planing this edge than are absolutely necessary to get it straight and square. The final stroke should be taken the full length of the board and the shaving should be very thin. Mark this edge as in Fig. 27. It is to be known as the face edge.

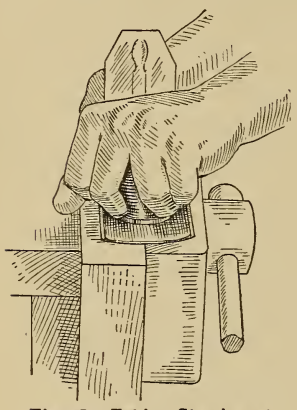


Fig. 35—Taking Shaving at High Arris

CHAPTER VII

SQUARING UP MILL-PLANED STOCK

(Continued)

Gauging for Width

HAVING planed and marked the face side and face edge, the next step is to mark the desired width. Figure 36 shows the tool used for this purpose and the manner of holding it while setting it. It is called

Fig. 36—Holding and Setting Marking Gauge

a marking gauge. Gauge sticks are marked off like a ruler into inches and fractions. These markings are so unreliable, however, that it is better not to depend upon them. Figure 37 shows the position of the gauge in action. The top of the spur is tipped forward so

as to make the cutting edge enter the wood at a slight angle while the tool is being pushed forward. The head of the gauge must be held against the face edge.

Planing Second Edge

The second edge is planed in a manner similar to that of the first. The gauge line limits the amount of wood that may be removed. Care must be taken, therefore, to test with the try-square as was done on the first edge while approaching the line, so that any

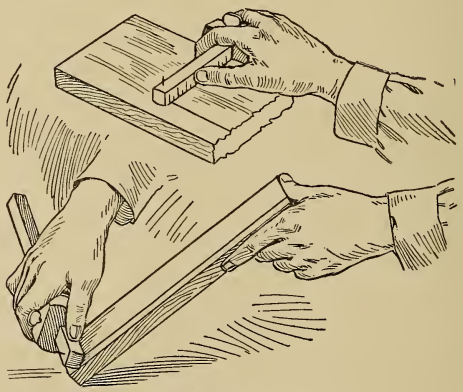


Fig. 37—Gauging for Width

irregularities may be corrected by the time the line is reached.

The test for straightness such as was given the first edge is not necessary here, if the gauge line has been planed properly. The first edge being straight and the second one gauged therefrom, the second edge will be straight too if the gauging has been carefully done. If there is more than one-fourth of an inch of

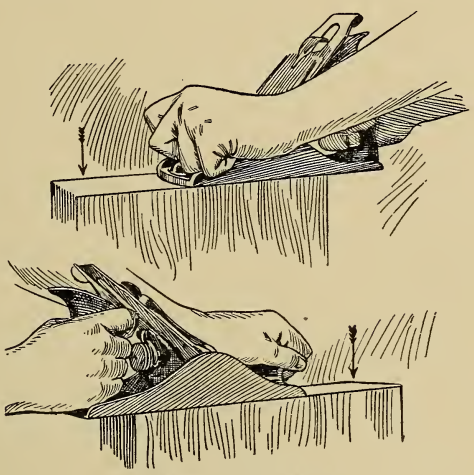


Fig. 38—End Planing

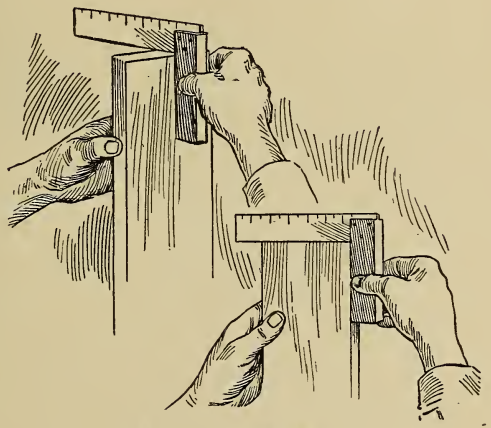


Fig. 39—End Testing

waste outside the gauge line, it should be ripped off, cutting parallel to the line and about $\frac{3}{16}$ in. in the waste.

Planing Second Surface

Since stock that is S-2-S has the correct thickness, it is necessary in preparing this surface merely to remove the mill-marks, the smoothing plane being used as described in planing up the first board surface.

Planing First End

End planing differs from edge and surface planing in that there are no shavings, only sawdust, because the cutting takes place across the grain. Care must be taken in end planing not to sliver and break the arrises. This can be avoided by not planing entirely across the end. Plane about two-thirds of the way, then reverse and plane from the other direction (Fig. 38).

While the block plane is especially designed for doing end planing, any of the other planes may be used if a vise is at hand in which the piece of wood may be placed so as to allow both hands free for holding the plane.

The Tests—The first test for accuracy in end planing is made by holding the beam of the try-square firmly against the face edge and lowering the blade until it rests upon the end of the piece of wood. By holding the piece up between the light and the eye, any unevenness will be visible (Fig. 39). The second test is similar to the first except that the beam of the try-square is held against the face side instead of the face edge. Continue planing until both tests show no light between the try-square blade and the end of the wood.

Measuring the Length and Lining

From the end just squared up measure and mark the length desired, Fig. 40. With try-square and knife,

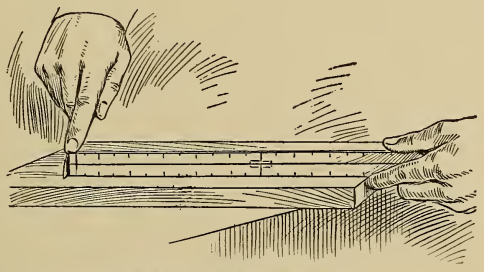


Fig. 40 — Measuring Length

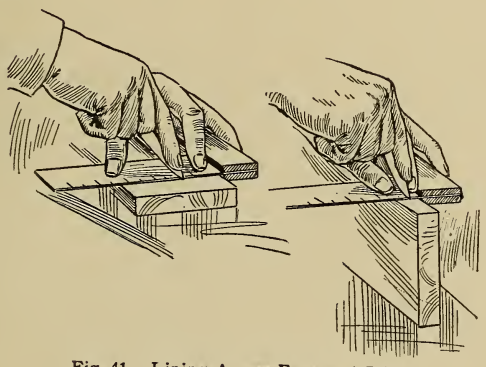


Fig. 41 — Lining Across Face and Edge

mark lines (Fig. 41) at this point across face side and face edge. If there is more than $\frac{1}{8}$ in. of waste, saw it off, sawing about $\frac{1}{16}$ in. outside and parallel to the line.

Planing Second End

The second end is to be planed to the lines just made. The two tests given the first end should be applied to the second end while approaching the lines, that the end may be square when the lines are reached.

This completes the squaring up of stock mill-planed to correct thickness.

CHAPTER VIII

SQUARING UP ROUGH STOCK

THE process of squaring up rough stock—stock which has not passed through the mill planer—is not so very unlike that for squaring up mill-planed stock. The main differences, however, are very important.

Leveling or Truing the First Broad Surface

Level up one of the broad surfaces for a face side, taking off as few shavings as possible. A level surface

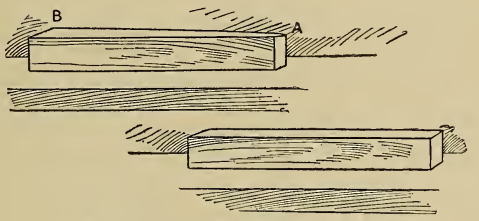


Fig. 42—Winding and a True Surface

is one of which all points lie in the same plane. To level a surface, therefore, means to plane off the high places. Figure 42 shows a surface "in wind" or not level or true; also, a true surface.

There are several ways of testing a surface to find whether it is true or not. An experienced mechanic would probably find the eye-sighting test sufficient This consists in closing one eye and sighting with the other along the length of the piece for straightness,

Fig. 43. Another test is to sight across the piece to see whether the front arris and back arris line up, i. e., whether they lie in the same plane, Fig. 44.

A beginner will find it advisable to use the following test in addition, until his eye has become trained in detecting inaccuracies. This test is used by mechanics

Fig. 43—Testing for Straightness

when great accuracy is desired. It consists in testing for wind by means of winding sticks and in testing for straightness of length and width by means of a straightedge. Testing for a wind, Fig. 45, is made by placing two straight sticks, having parallel edges, across the piece near the ends and sighting (with one eye) across their top arrises. If the surface is in wind,

the arrises will appear as in A, Fig. 46. If not in wind, the arrises of the sticks will appear parallel as in B, Fig. 46. The straightedge test for length is

Fig. 44—Testing for Twist

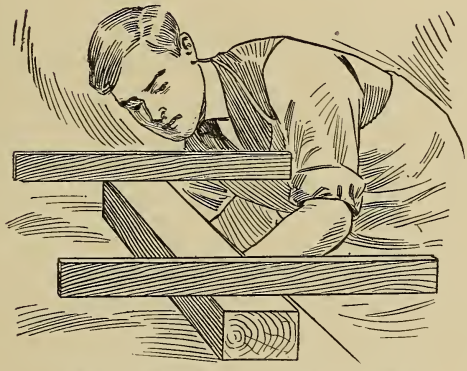


Fig. 45—Sighting for Winding of Surface

similar to that for the edge, Fig. 33. In Fig. 47 is shown the straightedge test across the grain.

A substitute for the winding-stick test, on pieces of

some width—three or more inches—consists in placing the straightedge along the two diagonals. The straightedge test for length and width must be given as usual, in addition to the diagonal test. These tests will show where and how much is to be planed and will need to be made frequently as the planing proceeds.

If the piece is in wind, two diagonally opposite corners will appear high. Plane diagonally across the piece until these corners are roughly leveled. It may be that the middle is on a level with these corners and the other two corners are low with reference to the center of the board. In this case, the diagonal planing will take the middle down as well as the two high corners. Finish by planing parallel to the grain, so as to leave a smooth surface. Put on the face mark.

Planing the First Edge

Straighten and square one of the edges for a face edge. This is done in the same way as for stock S-2-S, described in the preceding chapter.

Gauging for Width and Planing Second Edge

The directions for gauging to width are the same as those given in a preceding chapter, also planing for the second edge.

Gauging to Thickness

Since rough stock is variable in thickness, it will be necessary to set the marking gauge to the thickness wanted and mark sharp lines, one each on the two edges. Keep the head of the gauge against the face side in so doing.

Planing and Testing Second Surface

Since the face side was leveled and the thickness gauged from this, the second surface ought to be level

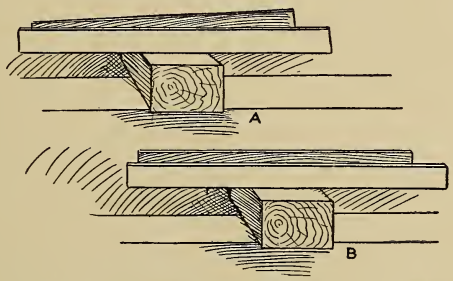


Fig. 46—Showing a Winding and a True Surface

Fig. 47—Testing Across the Grain

and true, if the planing is made to stop at the gauge lines on the two edges and if the middle of the board is neither high nor low with reference to these lines. To see whether the middle is high or low, place the straightedge across, as in Fig. 47, and test at a sufficient number of places to show the true condition. This test must be made frequently while approaching the lines, that the surface may be level when the lines are reached—at least not low in the middle, for there would be no remedy for that without decreasing the thickness below what is desired.

Securing Length

The directions for planing first end, measuring length and lining and planing second end will be found in preceding chapters under the same heads.

CHAPTER IX

WHETTING PLANE IRONS AND CHISELS

PLANE irons and chisels are sharpened in precisely the same manner, so that a description of sharpening only one—the plane iron—will be given.

Release the plane iron and cap from the throat of the plane by lifting the cam on the cap. Separate the plane

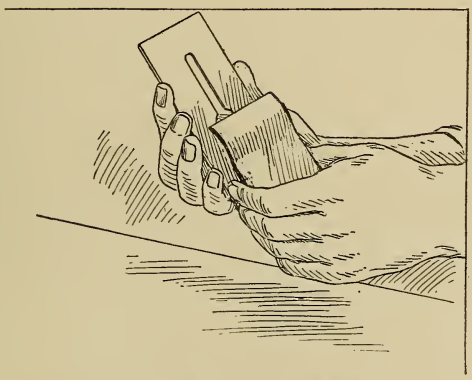


Fig. 48—Taking the Irons Apart

iron and cap iron—do not remove the cap screw, but slide the irons lengthwise until the screw head will pass through the opening made for it, as shown in Fig. 48. Place a little oil on the stone and, holding the plane iron as shown in Fig. 49, proceed to whet the cutting edge. The iron must be held neither too high nor too low. If held too high, the edge will be blunted

and ruined, and a new edge must be ground on the grindstone. If held too low, the whetting takes place on the heel of the bevel and does no good, since it does not allow the stone to touch the edge of the iron. To tell when the tool is at the correct angle, draw the oil to one spot in the center of the stone. Place the iron with the bevel in the oil and the rear end down so the iron is flat, or nearly so, on the stone (Fig. 50). Gradually raise the rear of the iron until the oil can be seen

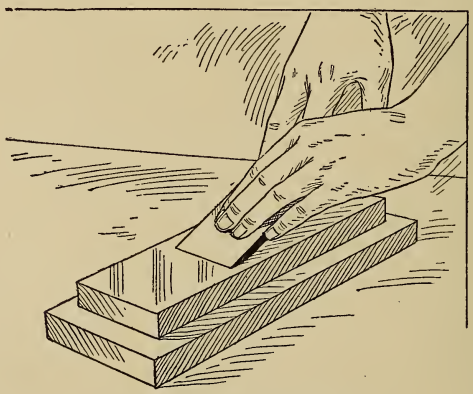


Fig. 49— Proper Pitch of Iron

to spurt from under the cutting edge. The iron is then in position. Now move the iron either back and forth the full length of the stone or give it a circular motion, in either case striving not to change the angle at which it is held.

After the whetting has been continued for some time, considerable pressure having been applied, and the test for position having been frequently made, a rubbing of the fingers down over the face side and out

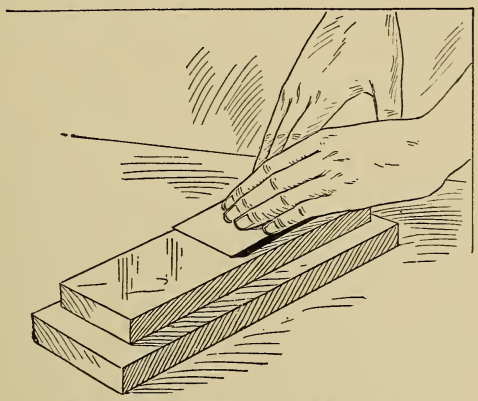


Fig. 50—First Position in Testing Angle

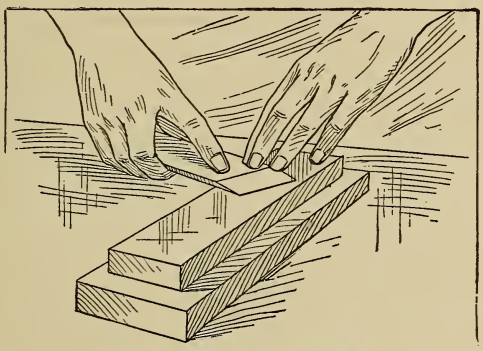


Fig. 51—Removing Wire Edge

over the cutting edge will reveal a "wire edge." This must be removed before the iron is used again. To do this, hold the plane iron, face down, so that it touches the stone along its whole length, and give it a forward and downward movement on to the stone (Fig. 51). This generally bends the wire edge under and cuts it

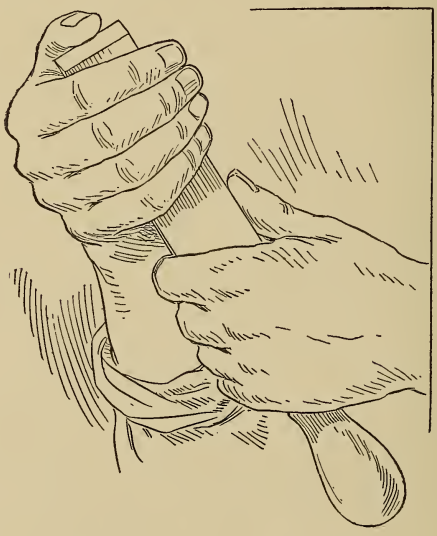


Fig. 52—Testing for Sharpness

off. Sometimes, however, it simply bends it back on the bevel. In this case the bevel must be whetted again slightly to bend the wire edge back on the face, when the above operation may be repeated. Sometimes it takes several turnings to remove the wire edge.

After the wire edge has been removed, the iron must

be tested for sharpness. There are several ways of doing this. One way is to hold the iron up to the light; if a white line appears, the edge is blunt and should be whetted more.

Another way is to draw the edge of the iron along the thumbnail, feeling for friction. If the iron is sharp, it will cut the nail slightly and the resulting friction will be perceived by the worker. If the iron is dull, there will be no cutting and therefore no friction, in which case more whetting will be necessary.

A mechanic generally uses the second method, but instead of the thumbnail he uses the ball of the thumb (Fig. 52). This is a more sensitive test and therefore more satisfactory. The ball of the thumb is calloused and if slight pressure is applied as the edge is drawn along the thumb, no harm need be done. When the edge is found satisfactory, put the plane iron and the cap iron together and place them in the throat of the plane.

CHAPTER X

GRINDING PLANE IRONS AND CHISELS

WHEN plane irons have been whetted repeatedly, the end of the tool becomes so blunt that it will not do satisfactory work, and it cannot be made to do so by any amount of whetting, until the surplus metal at the heel of the bevel has been removed on a grindstone.

Figure 53 shows the manner of holding a chisel on the stone. The plane iron is held similarly. The tool should make an angle of about 20 to 25 deg. with the stone If the tool is to be used for cutting hard wood, it will need to be ground at about 20 deg. If it is to be used in cutting soft wood, it will take a longer bevel. The rule is: Keep the bevel as long as the temper of the tool and the nature of the wood to be cut will allow. The sharper the angle, the easier the tool cuts. It must not be so sharp as to become nicked or break in usage.

Plenty of water should be kept flowing upon the stone, or the resulting friction will heat the steel and draw the temper, making the metal soft so that it will not stand up or hold an edge. Then, too, the water helps to keep the stone clean by washing off the particles of steel which would clog up the pores of the stone.

In freehand grinding, the stone should revolve toward the worker. It will cut faster and also help to prevent the forming of a wire edge. Try to keep the tool at a constant angle. Frequent changes of angle,

intentional or not, will cause much extra labor and result in either a poor job or a waste of good metal. Move the tool across the entire width of the stone so as not to form a hollow in the center of the stone.

Grinding freehand is not so easy as it looks, and a

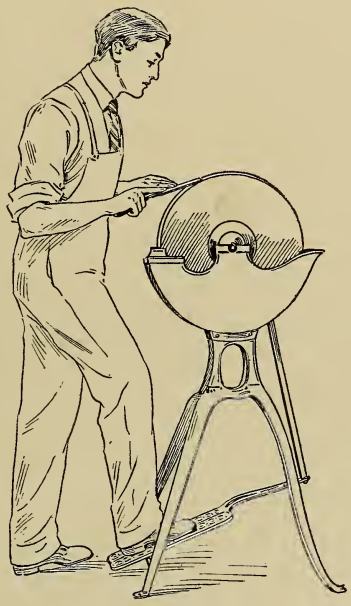


Fig. 53 — Position in Grinding

beginner may find it convenient to rig up a grinding device. He should, however, practice the freehand grinding until he masters it. With the rig now to be described, excellent results will be obtained with but little practice: The stone should be placed near a

wall, preferably in a corner of the room. Unless the stone is to be kept true by means of a truing device, it will be safest to have it revolve from the tool. Cut a piece of oak or other hard wood, 1¾ in. square.

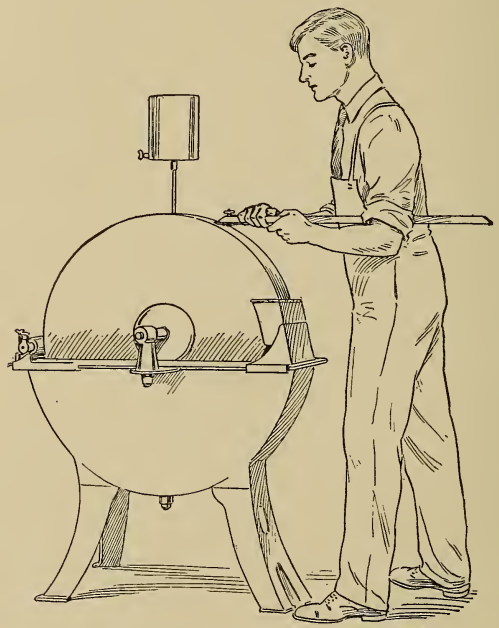


Fig. 54—Attachment Fastened to Wall

Shape the ends as shown in Fig. 55. Fasten an angle iron at one end and in the other bore a hole and insert the metal holder. This holder or toggle bolt is simply one of the irons used by marble workers to fasten the marble slabs to the wall and can be bought at any

hardware store for a few cents. The common nut which ordinarily comes with it should be exchanged for a thumbnut, to facilitate rapid adjustment.

The plane iron is fastened by slipping this holder through the slot in it, giving the holder a quarter turn and tightening the thumbnut. For chisels, a block of

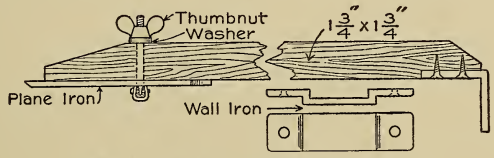


Fig. 55 — Detail of Grinding Attachment

wood will be needed to place under one side of the holder to make it bear on the tool properly.

The length of the wooden arm can only be determined by trial, as the distance of the stone from the wall, the size of the stone, the position of the rest upon the wall, and the cutting angle desired, all are factors to be considered.

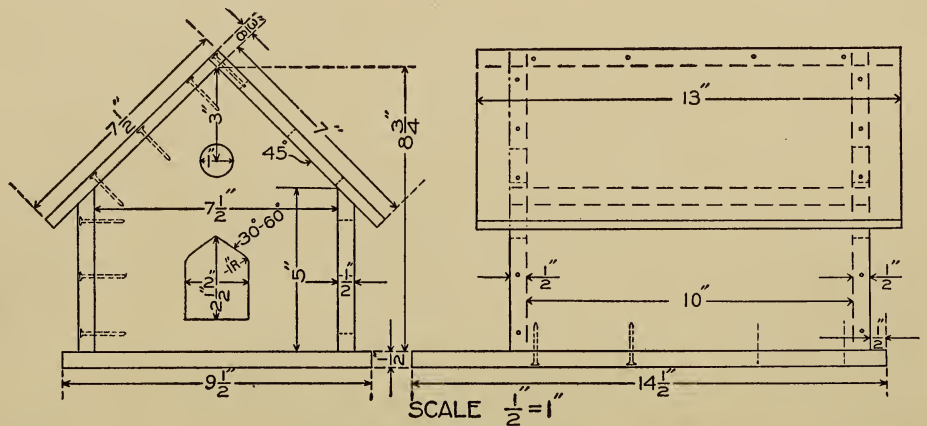


Fig. 56 — Details of the Bird House

CHAPTER XI

MAKING A BIRD BOX

NOW that the beginner has learned how to order, how to lay out and cut his stock and how to square it up, he may profitably begin the making of the six pieces which will be described hereafter. The projects are so arranged that each one introduces some new

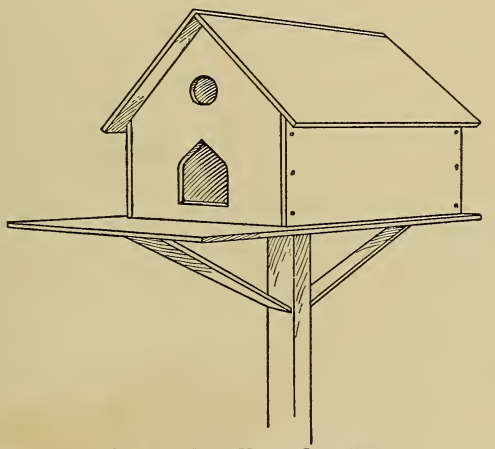


Fig. 57—Bird House Complete

wood-working process. By the time the six are completed, the beginner will have had experience in the essential processes, such as boring, chiseling, etc., and in the making of the most important joints. Each project is more difficult than the preceding one, so that

the last will, if completed satisfactorily, indicate considerable skill and knowledge of the elementary principles of wood-working.

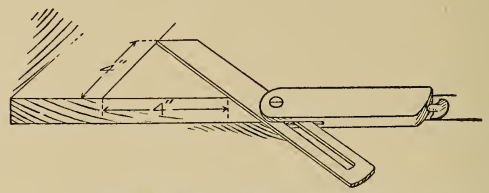


Fig. 58—Setting Angle of T-Bevel

First, from the mechanical drawing of the bird house (Fig. 56), make out a stock bill in the form indicated in Chapter I. With this bill before you, lay out and cut the stock as directed in Chapters II and IV. Begin on the easiest pieces by squaring up the bottom or floor and the two roof boards shown in the perspective sketch, Fig. 57. Follow Chapters VI and VII or Chapter VIII, according as the stock is mill-planed or rough.

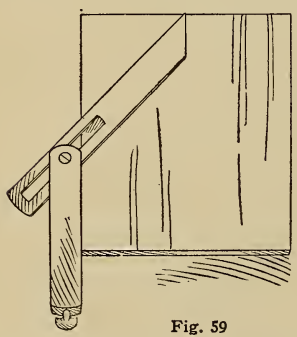


Fig. 59

The ends of the house may now be made. They should be squared up in the usual way except that only one end of each need be squared and no attention need be paid to the length, provided you are careful not to take off too much in squaring the first end of the board. These two house ends are alike in size; they are duplicate parts so the beginner will need to know how mechanics would handle them so as to save time. Make

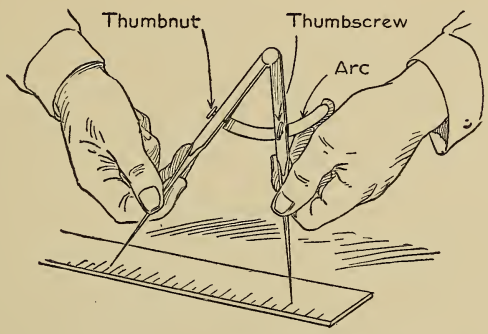


Fig. 60 — Setting Dividers

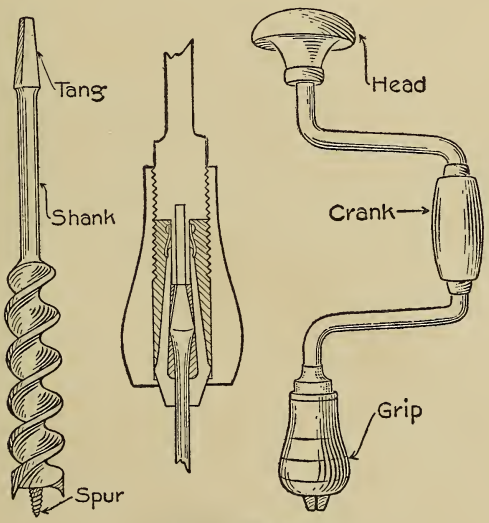


Fig. 61 — Brace and Bit

the ends and sides even and, with light brads, nail the two parts together, nailing only in those parts that will not show the nail holes. The 45-deg. slopes are now to be laid out by means of the bevel-square or T-bevel. Figure 58 shows an easy way to set the bevel to 45 deg. Measure off on the edge of a straight board

Fig. 62 — Boring a Hole

any given distance, say 4 in. With the try-square, place a line across the board at one of these marks and measure from the edge of the board along this line an equal distance, 4 in., and adjust the blade of the level as shown. Lay off the slopes by marking along the bevel placed as in Fig. 59, and from the other edge. Saw a little outside of the lines, and plane to them accurately, testing with the try-square.

Separate the pieces and lay out the door and the centers of ventilating holes in the gables. A pair of dividers will be needed to lay out the door. Figure 60 shows the manner of setting them. After the approximate setting has been secured, the thumbscrew is tightened and the thumbnut is used to set the points exactly.

For boring the holes, there will be needed a brace and a 1-in. auger bit, Fig. 61. Braces are of two kinds, plain and ratchet. The latter has the advantage over the former in that it can be used in corners and up against a wall where only a partial turn is possible. Auger bits vary in size by sixteenths of an inch. The size of an auger bit is indicated by a number on the tang. If a single number, it is the numerator of a fraction whose denominator is sixteen.

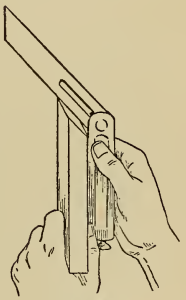


Fig. 63

To insert the bit, hold the grip in the left hand and with the right revolve the crank until the jaws are open wide enough to take in the entire tang of the bit. The jaws should clamp upon the shank. Insert the bit and close the jaws by revolving the crank in the reverse direction.

To bore the holes, place the piece in the vise, Fig. 62, and bore until the spur appears on the reverse side. Reverse the position of the piece and, inserting the spur in the small hole just made, finish the boring. This method prevents any splitting of the arrises. The bit must be held perpendicular to the surface of the wood. Sight the whole brace and bit frequently from one direction, then from a position at right angles to this, until the bit has entered

well into the wood. A small coping or scroll saw may be used to finish the cutting of the door Saw right up to the line, keeping the saw cut or kerf on the waste wood.

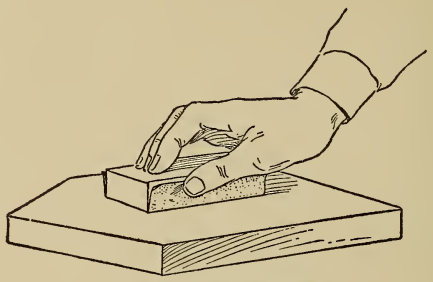


Fig 64 — Sandpapering

Make the two sides of the house. These pieces are to be squared up in the usual manner, except that in obtaining the width, the bevel square is to be used for testing the angle instead of the try-square, Fig. 63. Test constantly while approaching the line. If by accident the line is overplaned, it will be necessary to put on new lines for width and to lay out anew and rework the length of the ends of the house to correspond

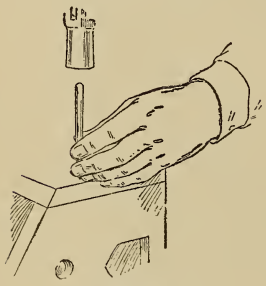


Fig 67
Setting Nail

The different pieces should now be sandpapered nice and clean. Sandpaper should not be depended upon to do the work of the edged tools. The edges and ends of the pieces which are to be placed against other pieces to make joints should not be sandpapered. A better joint

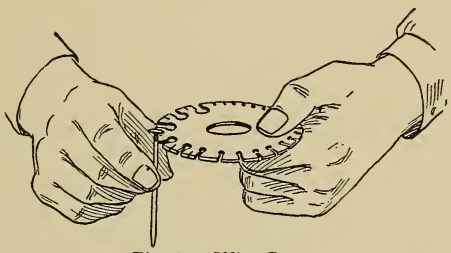


Fig. 65 — Wire Gauge

Fig. 66 — Nailing

is obtained by using the planed surface, since sandpapering has a tendency to round the edge.

Fold the sandpaper sheet into at least four parts and make a block on which to place it. Make the block of such a size that the paper will not extend over the ends but will extend up the sides far enough to allow the fingers to grasp them firmly (Fig. 64). A good workman sandpapers so as to keep the arrises sharp, unless it be on the arm of a chair, etc., where the sharp arris would injure the hand.

We are now ready to assemble and nail the parts together. There will be needed some nails, either common or finishing. Common nails have flat heads; finishing nails have small round heads and are more suitable for fine work. Casing nails have small heads, but with slightly thicker bodies than the finishing. In ordering nails, specify the length in inches and the thickness according to the gauge of wire. Figure 65 shows a wire gauge. It is the slot and not the circular opening that indicates the gauge.

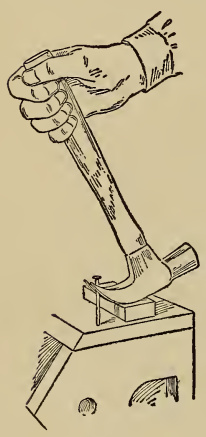


Fig. 68
Drawing a Nail

Place an end of the box in the vise, Fig. 66, and, standing so as to be able to sight along the lower piece, drive in the nails. Drive the nail almost in and finish with a nail-set (Fig. 67), so as not to mar the surface of the wood. Should the nail not enter properly, withdraw it (Fig. 68), and start it in another place nearby. Nail this side to the other end, then nail the other side in place. Put on the bottom or floor, then the roof boards.

CHAPTER XII

MAKING A TABORET

REFERRING to the working drawing, Fig. 69, make out a stock bill of material needed. If possible, use chestnut for this piece. It is easily worked, being soft wood, and takes a fine finish, owing to its open grain.

The top and shelf are octagonal. To make them, square up the two pieces to size in the usual manner. After this has been done so that the two pieces are of the same size as well as square, draw the diagonals, the lines of which extend from corner to corner across the board—or at least draw enough so that they shall cross and indicate the center of the boards. With the rule measure accurately from each of the four corners each way, along the edge and end, a distance equal to one-half a diagonal. Connect these points as shown in the top view of the working drawing. The eight sides should be of the same length. Saw off the corners and plane to the lines.

Square up the four legs to width, and if rough stock, to thickness. Since the top end is to be rounded, it is necessary to square only one end of each piece. Before rounding the tops or shaping the sides of the legs, it is advisable to lay off and cut the dadoes, the grooves into which the shelves are to be fitted. To lay these out, place all four pieces on the bench side by side, face edges up, squared ends evened, and measure and mark with a knife point the locations of the sides of the dadoes. Separate the pieces, after having squared

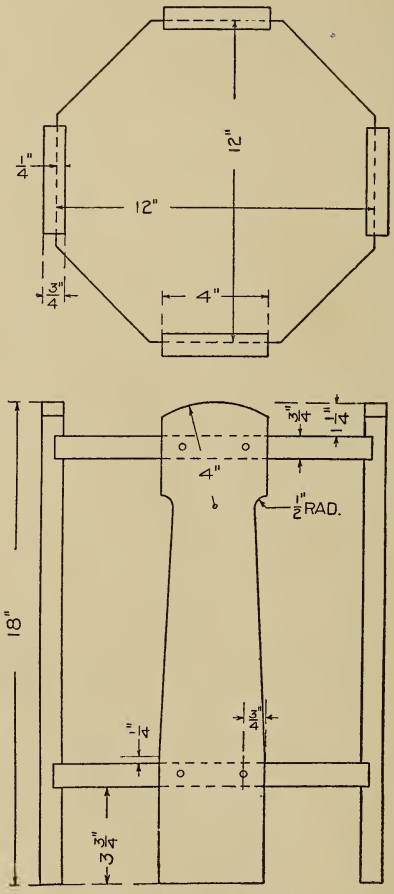
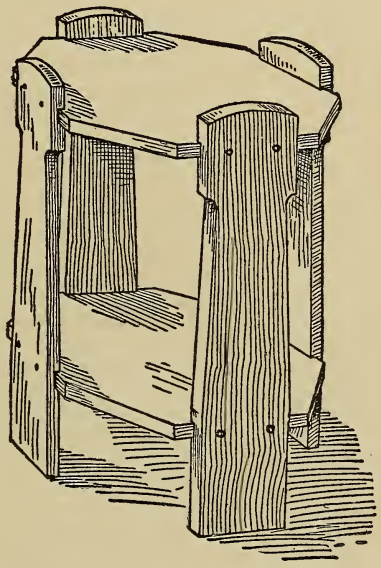


Fig. 69—Details of Taboret

knife lines across the edges, and carry these knife lines across each of the face sides. Carry these lines across the second edges also. Set the gauge for the required depth and gauge between the knife lines on the two edges.



The Taboret

Before cutting the dadoes, it is well to be sure that none of them will be too wide. To do this, place the legs in the positions they are to occupy relative to one another in the finished piece, then mark with corresponding figures or letters the edges of the shelves and

the dadoes into which they are to fit. Test each dado by super-imposing its shelf edge upon it. If the surface planing of the shelves was carefully done, all joints ought to answer the test. Should there be any variation, care should be taken to move only the lines representing the lower edges of the dado. In marking the corresponding members of a joint, Roman numerals should be cut with a chisel in the edge of the shelf deep enough to be visible even after the stain and filler have been applied. The dado should be marked lightly with pencil until the groove is cut, after which the Roman numeral should be chiseled in the bottom of the dado. The finish of stain and filler should be applied before the members are assembled. Time is saved and a better finish obtained by this method of procedure.

The best way for the beginner to work the dado is as follows: Take a tenon saw, Fig. 70, and saw about 1-16 in. inside and parallel to the lines that represent the sides of the dadoes. In using this saw, the cut may be begun on the arris near to or away from the worker. If it is begun on the near arris, the handle should be held lower than the point where the cutting is to begin and be raised gradually as the teeth progress across the surface of the board. If the cut is begun on the far side, the handle should be held high in starting and be lowered gradually as the cutting proceeds. The saw blade should have the constant guidance of either thumb or forefinger of the left hand. The strokes should be short and easy at first. As the sawing proceeds gradually increase the number of teeth used, but continue the slow regular strokes. Saw only to the gauge lines, watching both edges while nearing the lines.

Having sawed the sides of all the dadoes, the next

step is to chisel to depth. Figure 71 shows the chisel used for paring. Fasten the work so as to leave both hands free to hold the chisel. Both hands should at all times be kept back of the cutting edge or serious

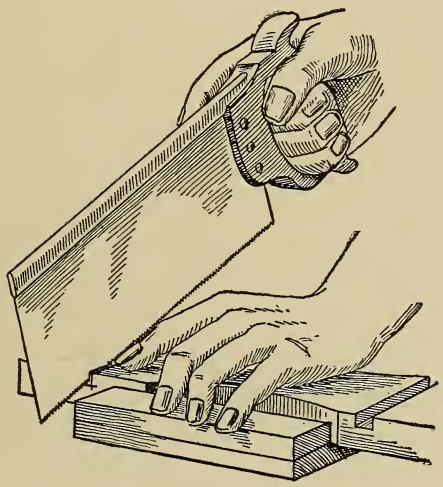


Fig. 70 — Sawing Dado

Fig. 71 — Chisel

accidents may occur. "Rough out" the waste material in the dado, cutting as much material at each stroke as may be removed by tapping the end of the chisel with the palm of the hand. On hard wood a

mallet should be used. Incline the cutting edge of the chisel upward to allow for slanting grain in the wood, Fig. 72A. Rough out a little over half way across the dado, holding the bevel side of the chisel up. Next, hold the chisel as in Fig. 72B; move the handle laterally, at the same time forcing the edge into the wood. This lateral movement is to give a shearing cut. Pare off very thin shavings while nearing the gauge line at the bottom of the dado and on the final cut place the cutting edge exactly in the gauge line. Finish the second side by cutting in a similar manner. A block into which has been driven a nail to the proper depth will indicate whether the proper depth has been obtained or not, Fig. 73.

The next step is to pare the sides of the dadoes. Hold the chisel as in Fig. 74, the left hand resting on the wood to hold it down and the fingers helping to guide the chisel edge. Only a very small part of the cutting edge of the chisel is used, the hardness of the wood and the strength of the worker determining how much. The chisel handle is inclined toward the worker at the start and is gradually worked forward vertically as the pressure is applied. It is very important that the worker stand so as to look along the line he is cutting, otherwise he cannot sight the chisel plumb. The sides of the dado will therefore not be perpendicular. The larger part of the blade, which is not used for cutting, is to be held against the perpendicular side of the dado already cut so as to aid in guiding the chisel.

The sides of the legs and the top ends should now be worked to shape. Place the four legs on the bench, side by side, and even the squared ends by means of the try-square. Measure from the squared end of one of them 14 in. and at this point square a light pencil

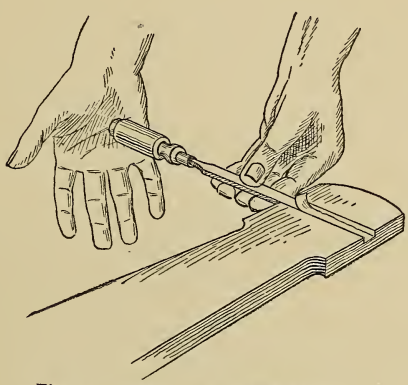


Fig. 72A—Removing Waste Material

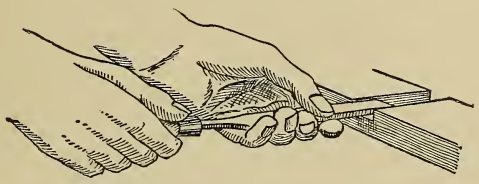


Fig. 72B—Finishing with a Paring Cut

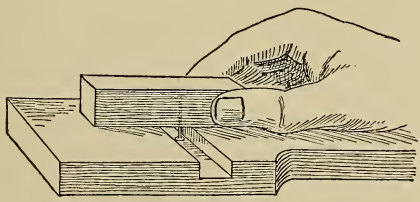


Fig. 73—Testing for Depth

line across the edges of all. Separate the pieces and carry this line across the faces of each piece, using try-square and sharp pencil. This line gives the location of the points from which the arcs are drawn for

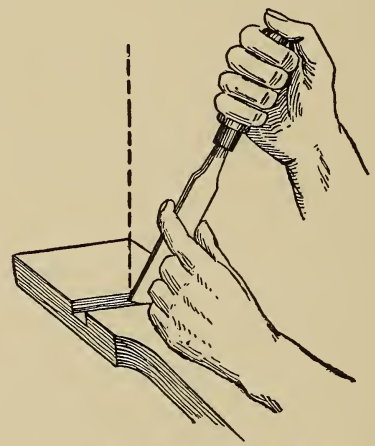


Fig. 74—Paring the Sides

Fig 75—Paring the Edges

curved top and sides. The drawing shows the radii. An easy way to make the curves at the side of the leg is to place two pieces together edge to edge in the vise and bore a 1-in. hole, thus making an arc of ½-in.

radius on each piece. Rip parallel to the straight lines and close to them and pare the edges as in Fig. 75. The top curves may be finished by sawing parallel to the line with the turning saw, Fig. 76, and

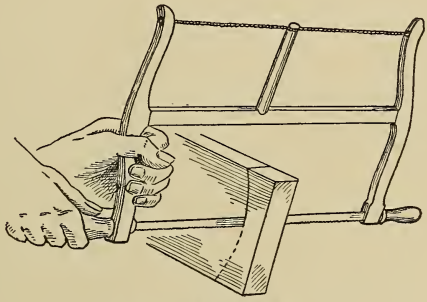


Fig. 76—Sawing the Curve

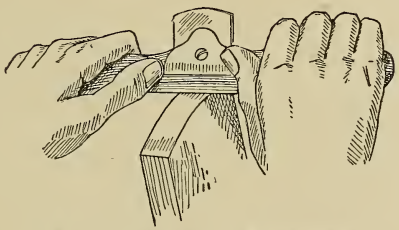


Fig. 77—Finishing with Spoke-Shave

finished with a spoke-shave, Fig. 77. Either of these tools may be pushed or pulled, whichever is most convenient. On a curve crossing the grain as does this, carpenters frequently use a plane instead of the spoke-shave.

The parts of the taboret may be fastened together

by means of round-headed screws. It will be necessary to locate by accurate measurement the places on the legs where holes are to be bored. Holes, somewhat smaller, just large enough to receive the core of the screw, will need to be bored in the shelf edges. Their locations are to be determined by superimposing the legs and marking through the holes already made in the legs. Screws, like nails, are designated by the number of wire gauge from which they are

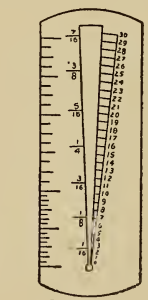


Fig. 78

Fig. 79 — Countersunk Hole and a Countersink

made and the length in inches. Figure 78 shows a wire gauge for screws. It must not be confused with the wire gauge for nails. The gauge is slipped over the screw just below the head. Flat-headed screws must have the holes countersunk. A countersunk hole and a countersink for making it are shown in Fig. 79. With a dark finish use blued screws; with a light finish use brass screws. The screwdriver bit will be found helpful in putting in these screws (Fig.

80). The gimlet bit (Fig. 80) will be needed for boring the smaller holes.

While it may be advisable to leave the surface planing of the legs until the last thing before sandpapering,

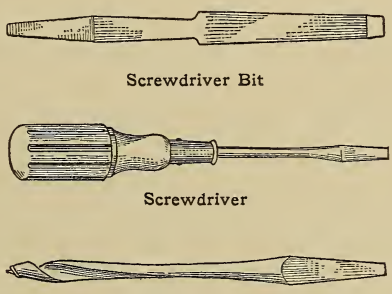


Fig. 80

staining and filling, it is absolutely necessary to have the surfaces of the shelves smoothed of their mill-marks before the dadoes are cut and fitted.

CHAPTER XIII

HOW TO MAKE AN UMBRELLA STAND

THE umbrella stand (Fig. 81) and the other pieces that will be described hereafter are best made of quarter-sawed white oak. It should be purchased mill-planed to the desired thicknesses and should be well seasoned. Using the accompanying working drawing, Fig. 82, first make out a stock bill and then work the pieces to the sizes and shapes indicated. The back frame should be made first, then the bottom and front, next the sides, and finally the pegs. The general directions for laying out duplicate parts, as given for making the taboret, apply to the making of this stand as well as to all other projects.

In the making of the back framework, a new joint—the cross-lap—has to be reckoned with. Proceed as follows: Having squared up the pieces of the back to their proper sizes, measure from their ends the distance the nearer edge of the joint is to be and at this point square a sharp line across the edge. It is taken for granted that the pieces are to be worked in pairs. By superimposing one piece on the other, find and mark with the knife point the location of the other edge. At this point square sharp knife lines across, using try-square and knife.

The pieces are to be so placed in the finished work that all the face sides shall be on the same side of the frame, therefore the cross lines will be on the face sides of half of the pieces, but across the back sides of the other pieces. It is well to lay the pieces in the

positions they are to hold relative to one another in the finished piece and mark the corresponding parts of the joints as was indicated in the marking of the taboret. They may be marked temporarily with pencil marks, but as soon as the joints are cut and the parts fitted,

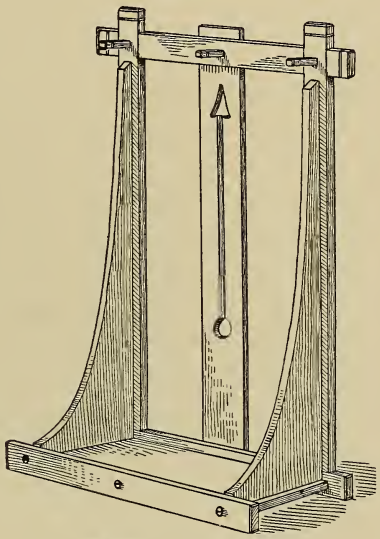


Fig. 81—Umbrella Stand

chiseled Roman numerals should be made in the bottoms of the grooves.

The parts of the cross-lap joint are to be laid out and the bottoms chiseled as was the dado of the taboret. Lines are carried across the broad surface where the groove is to be made, and down the two edges. Gauge lines between these knife lines, on the edges, indicate the depth. The gauge should be set to one-half the

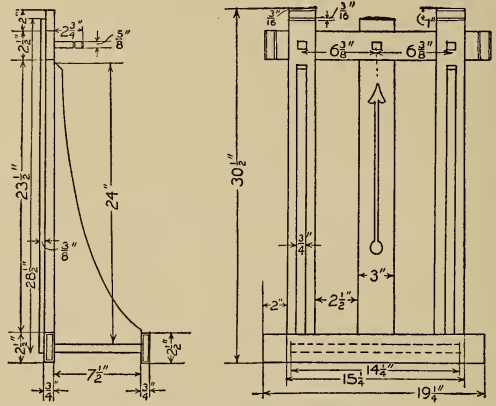


Fig. 82 — Details of Stand

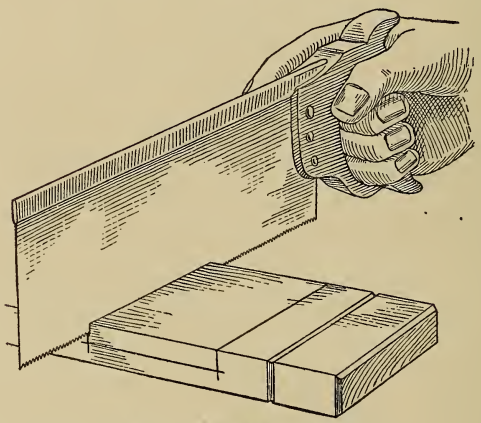


Fig. 83 — Sawing on the Line

thickness of the piece. The same setting will serve all the pieces, but it is of the utmost importance that the head of the gauge be held against the face sides only of the pieces. Beginners frequently think that because the groove is cut on the back side of some of the pieces, that the gauging must be done from the back side. If the pieces were all of the same thickness, and the

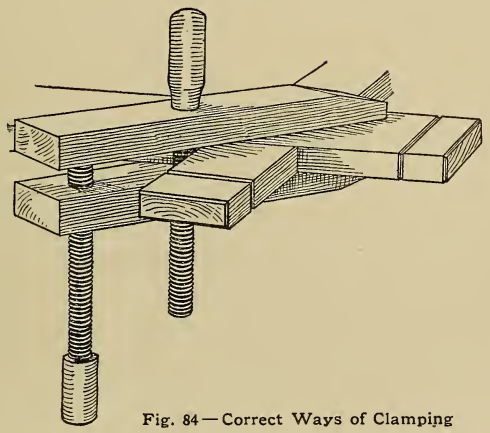


Fig. 84—Correct Ways of Clamping

gauge set exactly in the middle of that thickness, no harm would be done. This is very seldom the case. If the head of the gauge is held against the faces, no harm can be done, for should the groove be gauged too deep on one part, the other part will have the groove correspondingly shallow and the faces will be even and smooth after the parts are assembled.

The sides of these grooves should be sawn exactly to the lines, the kerfs coming on the waste wood (Fig. 83).

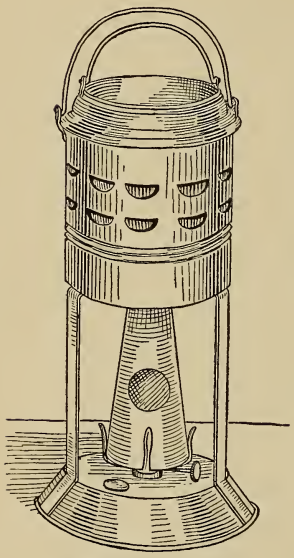


Fig. 86—Glue Pot

The wood being hard, no more paring than is absolutely necessary to make the parts fit properly should be required.

A good cross-lap joint is one in which the parts fit snugly, yet not so tightly as to spring the pieces out of line. Having fitted the parts, scrape the pieces and fasten the joints, using good hot glue and hand clamps.

Figure 84 shows the correct way of placing a hand clamp. Figure 85 illustrates the manner of rotating a hand clamp to open or close the jaws to the approximate setting. When the opening has been made, place the jaws, then tighten the shoulder spindle and after that the end spindle. In releasing a clamp, the end spindle must be released first.

Hot glue is obtained by boiling chip glue in a double boiler, Fig. 86. In the outer boiler is water. The glue in the inner boiler is heated by the steam and hot water of this outer boiler. To prepare the glue, place the chips in the inner boiler and pour water over them so that they are just covered. Allow them to soak over night, then heat. Cabinet workers usually heat the wood too in cold weather, a warming oven of steam pipes being used.

While the glue is hardening, the other parts may

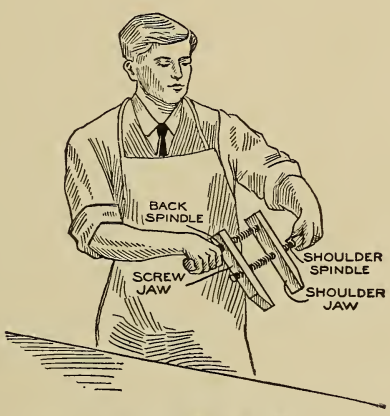


Fig. 85—Rotating a Clamp

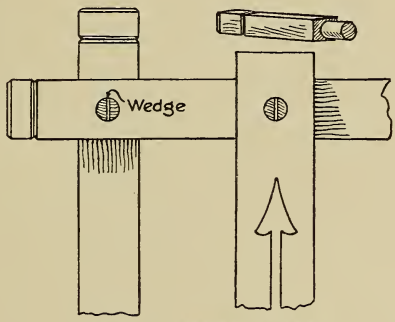


Fig. 87—Wedging the Pegs

be made. There is nothing requiring special instruction except, perhaps, the design. The arrow is merely suggestive. The one end is made by boring a hole

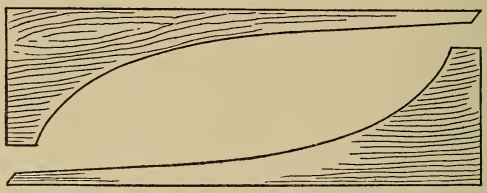


Fig. 88—Cutting End Pieces without Waste

through the slat. The shaft is cut with the ripsaw. The head is sawn with a coping saw or scroll saw.

Plane the pegs up in one piece. They are to be "let in" to holes bored into the frame. Use glue and in addition wedge the peg tenons from the back, Fig. 87. By working the end pieces as in Fig. 88, lumber will

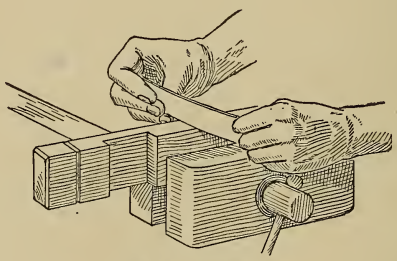


Fig. 89—Scraping

be saved. Put the rest of the frame together by means of screws.

A copper drip pan should be made for the bottom.

The copper need not be heavy since the tray is supported on all sides.

In this, as well as in making the pieces of furniture

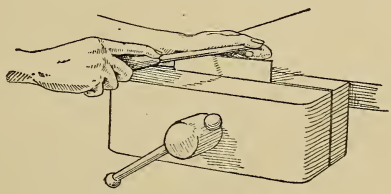


Fig. 90—Filing a Scraper

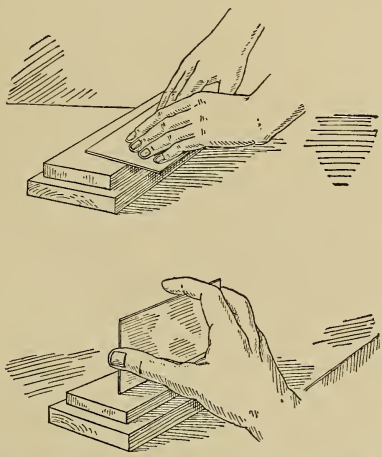


Fig. 91—Whetting and Removing the Wire Edge

to be described later, it will be necessary to have a cabinet scraper for smoothing the surfaces. The mill-marks should be removed as far as practicable with

the smooth plane. The scraper is to follow and will be found necessary where the grain is curled or crossed. There are special forms of holders for the scraper steels, but they are not necessary. Figure 89 shows a scraper in use. It may be either pushed or pulled. For a scraper to do good work, it must be sharp, be held at the correct cutting angle for the burr

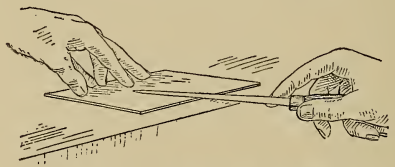


Fig. 92A—Flattening the Edge

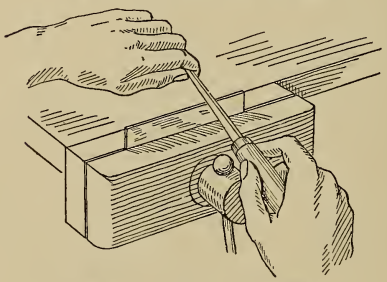


Fig. 92B—Turning the Edge

formed and be bowed by pressing with the thumbs so as to make the middle of the cutting edge cut first and most. A shearing cut is best and the stroke should be along the grain so that the hard grain may support the soft spring growth of wood.

When the scraper ceases to take off shavings, it should be sharpened. To do this, place the scraper in the vise and file the edge straight; it may be slightly rounded from end to end, if desired, and square across.

(See Fig. 90.) Then, by means of the oil stone remove the wire edges and leave the edge of the scraper with good square corners. (See Fig. 91.) Again place the steel in the vise and using a burnisher, a smooth piece of steel, draw up the arrises, as in Fig. 92-A. Now force the arrises down as in Fig. 92-B. The angle at which the scraper is to be held in cutting will depend upon the angle at which this burr is formed with reference to the scraper's surface. It can be told only by trial.

CHAPTER XIV

MAKING A MAGAZINE STAND

IN Fig. 93 is shown the perspective of a magazine stand which has been chosen to introduce three new kinds of fastenings or joints. Figure 94 gives the dimensions and from them the stock bill is to be made out. In ordering, it may be advantageous to combine the lengths of the shelves and of the sides. It should be noted that the shelves, of ¾-in. stock, are slightly narrower than the sides. They might be made of the same width, but in the first construction any little variation in the location of the joints makes no noticeable difference.

Square up the different pieces as indicated in the drawing, and shape their ends. The making of the joints comes next. Those on the shelf ends may be made first.

Figure 95 shows the joint for the two middle shelves, the housed joint. Place the two shelves on the bench, face edges up, and square two knife lines across them —one at each end—so that the distance between the lines shall be 14 in. If the pieces were cut the correct length, this should leave ¼ in. between each line and the end of the piece. Separate the pieces and with the knife and try-square, scribe knife lines entirely around each piece at each end. With the gauge set to ⅝-in., gauge on the two broad surfaces and on the ends as in Fig. 96. With the backsaw, rip to the gauge lines and cross-cut to the knife lines, keeping the kerf on the

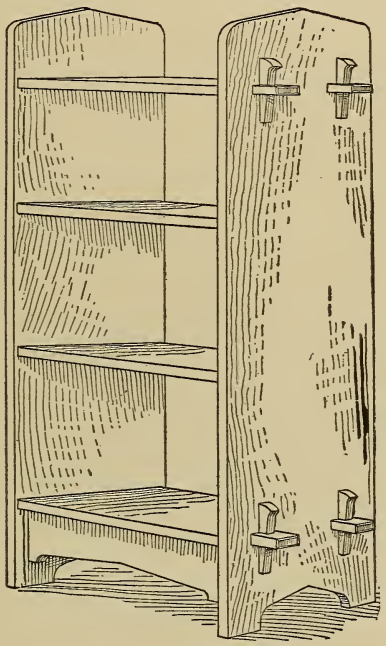


Fig. 93—Magazine Stand

waste wood. Saw to the lines accurately, so that no paring need be done.

Now make the tenons on the upper and lower shelves. Place the shelves on the bench, face edges up and even the ends. Square knife lines across the edges, equidistant from each end, with a distance of

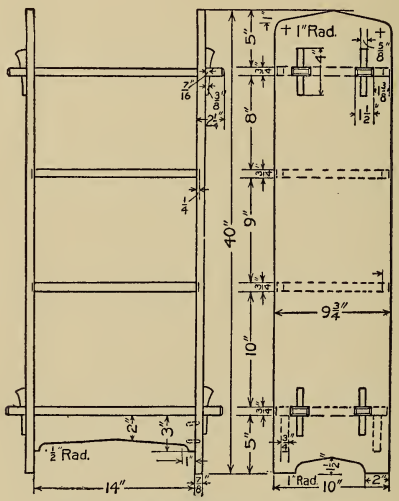


Fig. 94—Magazine Stand Details

14 in. between. If there was trouble in making the two previous pieces so that their length had to be made shorter than what the drawing called for, of course the distance just specified must be shortened correspondingly. Separate the pieces and scribe lines entirely around each end corresponding to the knife lines just made on the face edges. Lay the rule

along this line, Fig. 97, and with the knife, point off spaces as indicated. Setting the gauge spur in the mark nearest the edge, gauge all the tenons on the two broad surfaces as far back as the knife lines just made and also across the ends. Reset the gauge to the other mark and repeat until all are marked.

Before these tenons are worked or cut, the mortises for the keys should be laid out. From the knife line that represents the shoulder of the tenon, measure to-

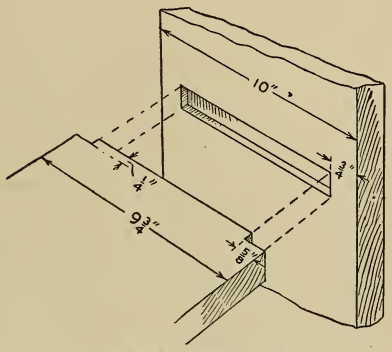


Fig. 95 — Shelf Joints

ward the end of the tenon $\frac{1}{32}$ in. less than $\frac{7}{8}$ in. The sides of the stand are $\frac{7}{8}$ in. thick and this $\frac{1}{32}$ in. less is to insure the pins pulling up tight against the sides of the stand. On the upper side of the shelf measure on toward the end from this line $\frac{7}{16}$ in. Square sharp pencil lines across the tenons at these points. Carry the first line entirely around the piece so that it will be across the under side of the board as well. Since the pins or keys have slant to make them wedge,

the second line will need to be only ⅜ in. further out toward the end of the tenon. Lay the ruler along these lines as was done in Fig. 97 and mark off points to indicate the gauge settings for the sides of these mortises. Gauge both sides of the board, and knife the pencil lines between these gauge lines. This knifing is to make it easier to chisel the mortise ends accurately. The chisel can be set in knife lines but

Fig. 96—Gauging the Ends

not in pencil lines. A little thought will make it clear why the knife was not used at the first lining.

Work the tenons and mortises for the keys. Rip with the backsaw to the lines, keeping the kerf in the waste, then cross-cut the exterior shoulders. To cut the inclosed shoulder it will be necessary to bore a hole, and then, using a key-hole saw, cut parallel and very near to the line. The remaining part may be pared away with the chisel, working from both sides. The ends of the tenons are to be chamfered slightly.

To work the mortises, bore a hole, and then, working from this hole, pare out to the lines. Bore from the smaller opening, the lower side of the shelf.

Everything is now ready for working the corresponding openings or mortises in the two sides of the stand. Lay the two sides on the bench with the face edges up, and even the ends. Measure off and square knife lines across the edges at the places where the mortises are to be made. If the shelves are of uniform thickness, both sides of the mortises may be laid off

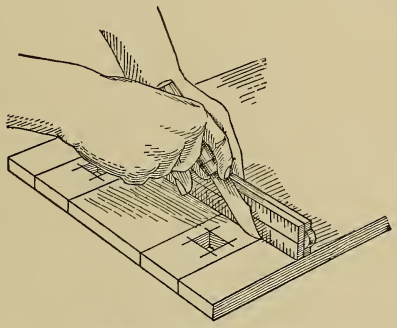


Fig. 97—Marking Spaces

by measurement. If not, it will be safer to lay off only the lower lines now and locate the upper lines by superposition. Separate the pieces and square the lines across the face sides, that is, the inner sides. Determine now and mark the way the parts are to rest in the final assembling. By laying the tenons on the corresponding cross lines for the mortises, locate the points from which the gauge settings are to be taken, Fig. 98. For the mortises of the upper and lower shelves, bore in each a series of holes close enough to one another to make one connected open-

ing. Use as large a bit as the mortise will allow safely. With the chisel, work from the hole toward the lines as was done in making the mortises for the keys. In working the mortises into which the ends of the middle shelves are to be housed it will be necessary to chisel lines parallel to the given lines, about

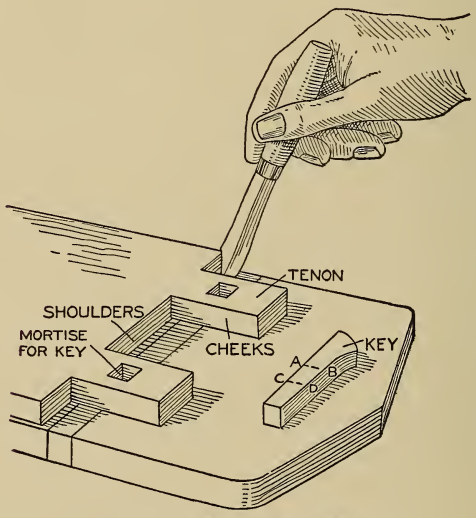


Fig. 98—Marking Mortises

$\frac{1}{16}$ in. in the waste, then work the mortise to depth. After this, the sides may be pared to the knife lines without danger of making the mortises too wide. In roughing out the bottoms, the chisel is to be held bevel side down. When nearly to depth, a router (Fig. 99) may be used.

The keys or wedges may be made in a variety of

shapes. The essential thing is to so design them that they will fit properly and not be likely to break. This matter of proper fitting is the only thing that necessitates definite measurements. Square up the keys to length, having first made a face edge and obtained the proper thickness. Midway between the ends, square two lines across the face side a distance apart equal to the thickness of a shelf, or ¾ in. Along one of these lines, AB, Fig. 98, measure from the face edge

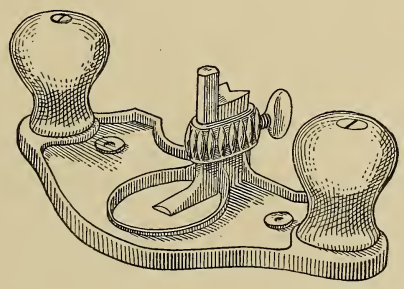


Fig. 99—Router

$\frac{7}{16}$ in. Along the lower, CD, Fig. 98, measure ⅜ in. The outline of the remaining unworked edge of the key, whatever its shape, must pass through these two points.

The two braces which are to be placed under the lower shelf are to have their ends doweled into the sides. Use a dowel ⅜ in. in diameter. Dowels can be purchased put up in bundles, each stick about a yard in length. Cut each pin about 1½ in. long. Slightly round the arrises and with the tenon saw or backsaw, saw a shallow slot the full length of the pin. This is to allow any surplus glue in the bottom of the

hole to escape when pressure is applied to force the dowel in. If the dowel were to fit snugly and the glue not allowed to escape when the pin is pounded in, the board might be split by the pressure of the glue. The most important thing in making a dowel

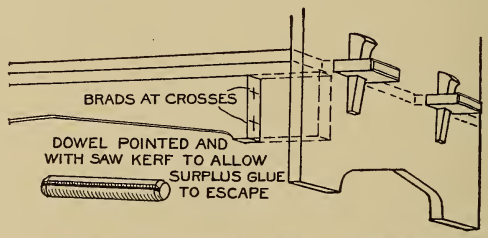


Fig. 100—Marking Holes for Dowels

joint is to get the holes laid out and bored in exactly corresponding positions. The centers for the holes may be laid out by measurement; but as easy a way—one that insures greater accuracy—is to drive two small brads into one of the members where the centers are to be, and snip off the heads so that the nails project about $\frac{1}{16}$ in. (Fig. 100.) Place the member against the other in its exact position and press these brads into the side of the other member. Remove the piece and the brads, using pincers for the latter, and then carefully bore the holes to depth. With a stick or a small brush, place glue on the sides of the holes that are in the ends of the brace, and insert the dowels. The stand is now ready to be assembled.

CHAPTER XV

MAKING A TABLE

IN Fig. 101 is shown the perspective of a table which contains a glue joint, closed mortise-and-tenon, and a pinned mortise-and-tenon joint. By means of the working drawing, Fig. 102, make out a stock bill and order the necessary lumber. The lumber for the top is to be cut in several pieces.

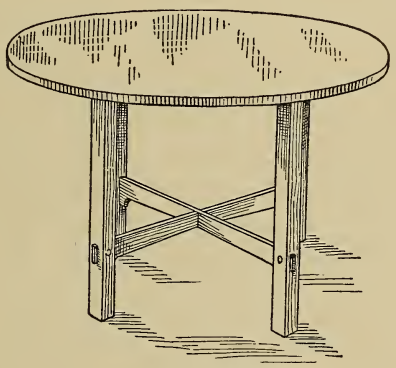


Fig. 101—The Table

The top may be built up first and the glue allowed to dry while the other parts are being made. If the boards are rough, one side should be planed up for a face side. Before jointing the edges, take a look at the ends of the pieces as well as the surfaces. Lay out

the pieces the way they are to be fitted to one another and mark them so that this order can be maintained hereafter. The annual rings should be fitted as in

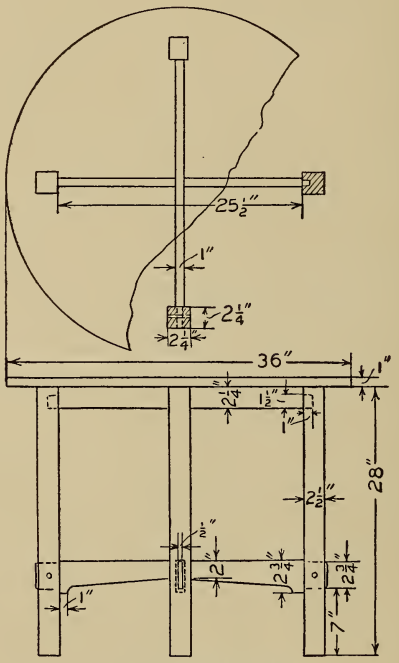


Fig. 102—Table Details

Fig. 103. If this is done, any warpage in one piece will tend to equalize that of its neighbor so that the general surface of the top will be level. Again, so plan the fitted parts that the surface grain may all run

in the same direction. If this is not done, it will not be possible to plane the surfaces over the joints without roughing up the wood from one direction or the other.

Place two pieces in the vise (Fig. 104), face sides together, and plane the edges until you think they are straight and level, no try-square test is necessary. Use a jointer and make sure the plane iron is ground straight across.

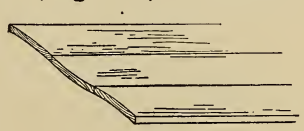


Fig. 103

Separate the pieces and, keeping one in the vise, set the other on this, both face sides on the same side of the work. Look at the joint to see whether any light can be seen through it. Also slide the top board endwise to feel for suction. Tap the lower board lightly to see if the upper will rock. Finally test as shown in Fig. 105 to see whether the face sides lie in the same plane or not. Plane until you get a good joint, for a poor glue joint is no joint at all.

When a surface of contact has been obtained that extends the whole length of the edges, and the face sides lie in the same plane, the clamps are to be gotten ready and the glue heated preparatory to gluing the joints. Figure 106 shows the manner of applying the glue to the edges. Figure 107 shows the boards in the clamps. Before applying the glue, have everything in readiness, the wood warmed, if possible, so that it will not chill the glue, in order that no time may be lost between applying the glue and the clamping.

When the glue has hardened, which usually takes 24 hours, the clamps are to be removed and the pieces surfaced and treated as one. Sometimes dowels are

used between glue joints. Many mill-men, however, do not consider them necessary.

The mortises and their tenons may be made next. The tenons on the upper stretchers are to be 1 in. long, so that the full length of each piece will be 27½ in. They are to be shouldered on three sides. Tenons may be shouldered on one, two, three or four sides. The reason for shouldering these on three sides and making one of these shoulders so large is

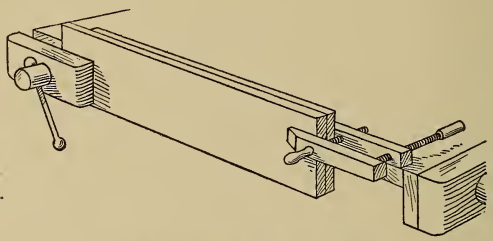


Fig. 104—Clamping Boards' Face Sides Together

to prevent any danger of splitting out the ends of the legs.

The important thing in laying out mortises and tenons is to keep the head of the gauge always against the face side or the face edge and to make as much use of the tool you hold in your hand as is possible before laying it down to take up another. As an illustration, the tenons of the upper stretchers are ½ in. thick. This leaves ¼ in. on either side. The amateur always wants to gauge both of these sides with the same setting of the gauge, ¼ in. This is contrary to trade practice, for, while it saves resetting the gauge, it makes the thickness of the tenons de-

pendent upon the thickness of the stock. The correct way is to set the gauge to ¼ in. and gauge all the tenons for this setting, holding the head of the gauge against the face side, then reset to ¼ in., plus the thickness of the tenon, ½ in., which makes ¾ in. Again hold the head of the gauge against the face side. In this way all the tenons will be ½ in. thick. no matter how much the pieces may vary in thickness. This same principle applies to gauging the mortises.

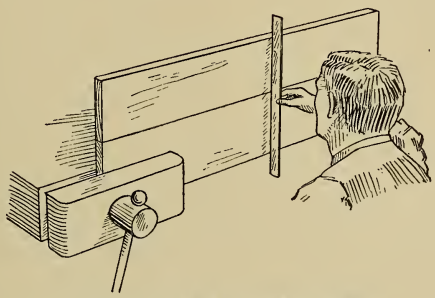


Fig. 105—Testing for Flat Surface

In laying off the shoulders and tenon lengths, place the pieces in the vise or clamp them together on the bench with the face edges up. The face edge of the upper stretchers is to be the lower edge of the piece and on the lower stretchers, the upper edge. Measure from the centers of the stretchers toward the ends one-half the distance called for. Measure on out toward the ends from these lines the length of the tenon. Mark these places with a knife and with try-square place knife lines across the edges of all the pieces. Separate the pieces and with knife and try-square carry these lines entirely around the pieces, observing

the rule about keeping the beam of the try-square against only the face side or face edge.

Observing the cautions given above, gauge the pieces on the surfaces and edges as far back as the shoulder lines just made and across the ends.

Using the tenon saw or backsaw, first rip carefully to the gauge lines, keeping the kerf on the waste but leaving no wood between it and the line. Second, crosscut to the knife lines that indicate the shoulders, Fig. 108.

Fig. 106 — Applying Glue to the Edges

The mortises are to be made next. Place the legs on the bench, face sides up, and measure off the locations of the ends of the mortises. The face sides are to be turned in and the mortises are to be worked in them, because they are more likely to be accurate than are the other sides, the shoulders are more likely to fit up snugly against them. Separate the legs and carry the lower lines entirely around. It will be well to use a sharp pointed lead pencil in marking around the legs for the lower mortises.

These mortises extend entirely through the legs so that the lines have to be carried all around the legs and were knife lines used, they would show badly on

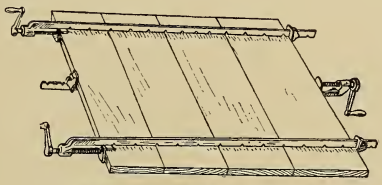


Fig. 107 — Boards in Clamps

the finished piece. Keeping the gauge head against the faces, gauge the sides of the mortises. Gauge all the mortises first at $\frac{7}{8}$ in., then at $1\frac{3}{8}$ in. The ends of the mortises which were penciled may now be knifed between the gauge lines to facilitate setting the chisel. Use the try-square with the knife.

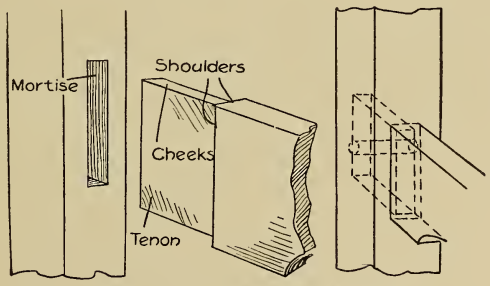


Fig. 108 — Tenon and Mortise Joint

In laying off for gauge settings, instead of measuring directly for them, the rule is placed as in Fig. 97 of Chapter XIV. The measuring is done from the

center of the piece each way. Afterward, the spur is set in these knife-point marks and the head pushed up against the face and the screw set.

There are two ways of cutting a mortise that are common. One way, which is especially advantageous in large mortises, is to bore a series of connected holes very nearly the entire length of the mortise. If the mortise is closed, as are the upper mortises in the legs of this table, the holes must be of uniform depth and correct. Figure 109 shows a simple device for obtaining uniform and correct depth. The block is to be sawed off to the length required by the depth of the mortise and the length of the bit. This can be determined by turning in the spur until the lips are ready to cut, then measuring the length of the bit up to the jaw. Subtract from this the depth of the hole and the length of the block is known. Beginning at the center, pare off thin slices of wood until the gauge and knife lines are reached. The sides of the mortise must be cut down plumb or the tenon cannot fit. In the through tenon and mortise the holes must be bored from each side of the leg and likewise chiseled.

The second method consists in only chiseling the mortise. Use a chisel that is the same width as that of the mortise. Stand so as to be able to look along the length of the mortise and cut out a V-shaped opening the depth of the mortise, Fig. 110. If the mortise is to extend through, cut a little over half way. Next, begin in the center and, with the bevel side of the chisel toward you, take vertical cuts and work gradually toward the other or far end. Cut the full depth of the mortise each time and pull the chisel toward you after each cut before removing it to break the waste from the sides of the mortise. Cut to within

⅛ in. of the end and then reverse the piece and cut out toward the second end. Pry out the chips occasionally. Finally finish the two ends out to the knife line but do not pry on them after these cuts. If the mortise is a through one, cut one side of the leg then reverse and cut from the second side, being careful that the cutting from the second side shall be plumb. Otherwise there will be danger of the chisel splinter-

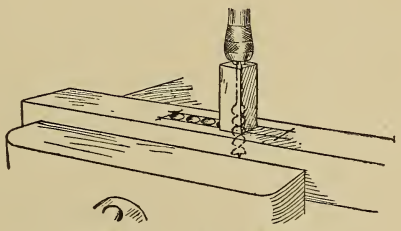


Fig. 109—Depth Gauge

ing the arrises of the first side. Never allow the chisel edge to be forced beyond two-thirds of the way through.

There remains the boring of the holes for the pins. Lay these out very carefully on the legs with rule, try-square and gauge. Instead of inserting the tenons and boring both mortise sides and tenons at once, lay out the holes on the tenons separately, very carefully. Use the same measurements as for the mortises, except that the center is to be drawn toward the shoulders about $\frac{1}{32}$ in., strong. This is to insure the pins pulling the shoulders up snugly to the leg and is called draw-boring. Too much draw-bore would split the tenon, therefore care must be taken to have everything just right.

Use ⅜-in. doweling for pins. Cut them off longer than the leg is wide and point the end so that it can find the way through without splitting off the arrises

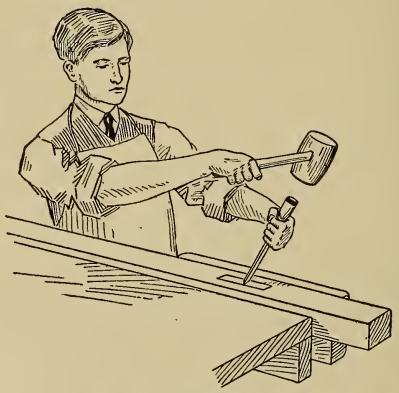


Fig. 110—Cutting a Mortise

of the hole at the far side. Use glue and clamps on the upper joints.

The top is to be fastened from the under side of the top stretchers by means of screws.

CHAPTER XVI

MAKING A CABINET

IN Fig. 111 is shown the perspective drawing of a cabinet that embodies in its construction the elementary principles of cabinet construction. This

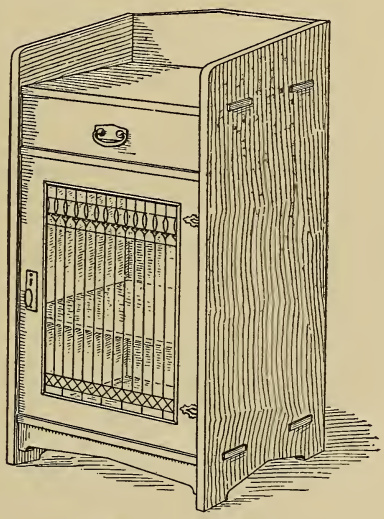


Fig. 111—The Cabinet

cabinet is intended primarily for holding music, either sheet or roll, but it will serve as a curio case equally well. Figure 112 gives the necessary dimensions for the case.

Square up the two sides and shape the ends. Square up the three shelves and work the tenons. The mortises in the sides may then be laid out and worked. These joints, including the dadoes of the stationary shelf next the top shelf, are laid out and worked in a manner similar to those joints in the magazine stand of Chapter XIV, the key and its mortise omitted of course The two shelves of ½-in. stock shown in Fig. 112 are to be movable and to be worked later.

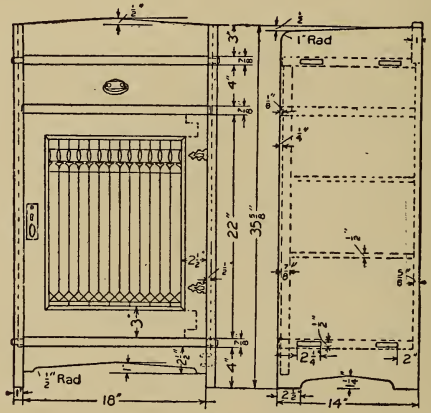


Fig. 112—Cabinet Details

The back of the cabinet is to be a paneled frame and is to be set into the sides of the cabinet one-half their thickness. The sides of the cabinet will, therefore, have to be rabbeted accordingly. A rabbet or rebate is a rectangular recess cut along the edge of a board. Figure 113 shows the rabbeted side of the cabinet. Rabbeting may be done with a chisel, the sides of the rabbet being first gauged deeply with the

marking gauge. The manner of loosening up or scoring the waste of the rabbet preparatory to paring the sides with the chisel is shown. If the rabbet does not run full length as in Fig. 113, the chisel and gauge must be used. The rest of the rabbet can be worked more advantageously, however, by means of a combination plane, shown in Fig. 22, Chapter V. This plane has a guide or fence which can be adjusted so as to hold the cutter on the board at the proper distance from the edge. It also has a stop which can be set

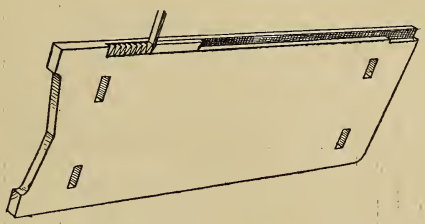


Fig. 113—Cutting a Rabbet

and thus cause the cutter to cease cutting when the desired depth has been reached. With these guides, no gauge line is necessary. In a rabbet like this one, the practical cabinet-maker would hardly take time to make a stopped rabbet, but would rabbet the full length of the side with the plane. Of course the lower part of the rabbet will not be filled by the panel but it will not be visible from the front.

Directions for Making Panel

The top backing of 1-in. stock may next be shaped after which the back paneling is to be made. The stiles and rails of this paneling are to be made of $\frac{5}{8}$-in. stock.

The panel proper is to be of $\frac{7}{16}$-in. stock. Figure 114 shows the detail. This is what is known as a flush panel, the panel being rabbeted on one side so that that side shall be flush or even with the frame. In making this panel, get out the stock for the rails and stiles about ¼ in. wider than the drawing calls for and somewhat longer. This is to make it possible to plane and fit the frame in place. In ripping their width, take pains to get them all to a uniform excess over the

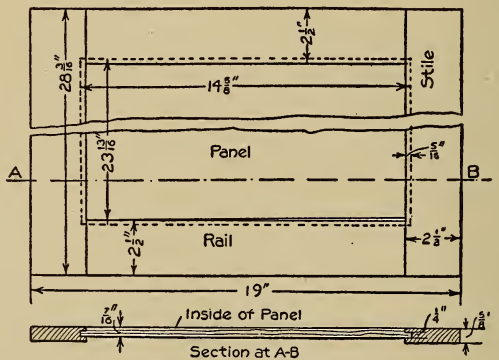


Fig. 114—Detail of Door

width called for. Work a face edge on each piece and plow a groove the full length of each as indicated in the cross-section of Fig. 114. Use the combination plane, adjusting it suitably. Lay off on the two rails the proper distance between the shoulders, and, using these as shoulder lines, lay out tenons that shall fit the grooves just made as mortises. Cut these tenons. Work the panel to size and rabbet the edges as called for by the drawing. If the lumber is well seasoned, it

will be necessary to make the panel slightly smaller in width than the dimensions given, to allow for swelling. Nothing need be allowed in length, for wood does not shrink appreciably along the grain. Get the bar clamps ready, mark the proposed location of the rails on the stiles, so that no time need be lost after the glue is applied, then glue the tenons and assemble the panel with its frame. Do not place any glue on the panel edge, unless it be a slight touch at either end in the middle. The panel must be free to move in the groove

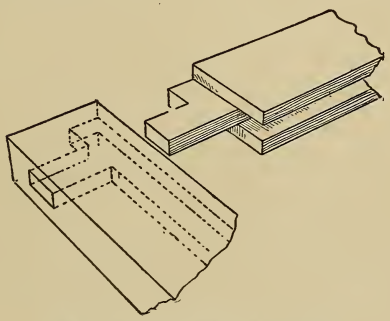


Fig. 115—Shouldered Tenon Joint

with the swelling or shrinkage, or it will split. The touch at the center of the ends is to hold the panel centering as it swells or shrinks. Place the clamps over the rails and adjust the blocks so that the pressure leaves the surface of the panel and frame level and out of wind. Test the panel with straightedge crosswise and diagonally, or sight across it with the eye.

This is a common way of making the frame for a panel and answers very well where the four sides of the frame are to be supported as in this case. On a door, however, stub tenons using the grooves as mortises would not be strong enough. In this case, a

deeper mortise and a longer tenon would be necessary. To make it possible to plow the full length of the rails and stiles, the tenon is shouldered as in Fig. 115. This is what is known as a haunched tenon-and-mortise. Mortise and tenon are made first and the grooves plowed afterward, the tenon and mortise being given the same thickness and location as the groove.

Doweling Front Brace

Shape the lower edge of the front brace, square the ends, then dowel them. After this, the surfaces of the

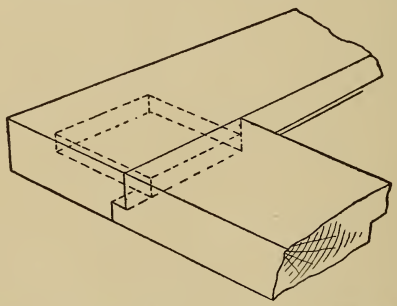


Fig. 116—Shouldered Tenon Joint for Glass Panel

parts already worked may be smoothed and these parts put together. The tenons of the horizontals and the doweled ends of the front brace are to be glued with good hot glue, but the entire backing should be fastened with screws.

Directions for Making Door

There remains to be made the drawer, door and shelving. The door may be made with a wood panel, in which case it will be worked by methods similar to those used on the back panel. It will not be necessary to use a flush panel. Use one with a thickness equal

to the width of the grooves. The haunched tenon-and-mortise should be used. If an art glass panel is to be used, as shown in the perspective drawing, it will be necessary to work the joints at the corners of the frame a little differently. Saw out the stiles and rails, as in the back panel, making them somewhat wider and longer than the dimensions of the drawing, but of uniform excesses. Plane face edges and lay out mortises and tenons on them as in Fig. 116—tenons on the rails and mortises on the stiles. The size and location of these will depend upon the rabbet or recess that is to be made to receive the glass.

It will be noticed that one shoulder of the tenon is worked enough longer than the other that it may extend to the bottom of the rabbet. This makes it possible to rabbet the full length of both stile and rail with the plane. Work the joints and then rabbet the edges. Glue the tenons and mortises and clamp the frame, sighting for wind and adjusting the clamping blocks so as to leave the door square and true.

Directions for Making Drawer

While the glue on the door is hardening, the drawer may be made. Figure 117 shows two styles of drawers. The first is easier to make but the second, the one with dovetail joints, is better and is the style used on fine cabinet work. Drawer fronts are usually thicker than the rest of the drawer stock. While the front is always of the same kind of material as the rest of the cabinet, the sides, back and bottom are usually of some close-grained wood such as yellow poplar. To make either style of drawer, get out the requisite number of pieces of the thicknesses necessary. Square them to size. The length of the drawer should be $\frac{3}{16}$ in. less than the place in which it is to slide. This is

to allow for swelling. The drawer front, however, may be squared up to a length equal to that of the opening, allowing its ends to project beyond the sides of the drawer. This will allow fitting the front without having to plane the sides of the drawer. Plow the grooves

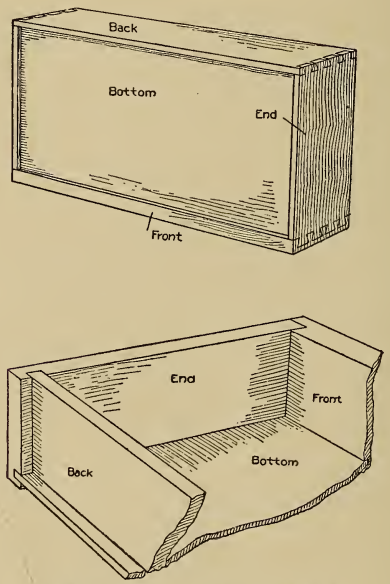


Fig. 117—Two Styles of Drawers

in which the bottom is to rest in the front and sides, also in the back of the dovetailed type. Lay out and cut the dadoes in the sides, into which the back is to be placed in the ordinary type, then the rabbeted corners on the drawer front. In this type the back of the drawer rests upon the drawer bottom. In the dovetail

type, the back of the drawer is the same width as the front. The dovetails are to be laid out and worked. The dovetail at the front is known as a half-blind dovetail and that at the back as a multiple plain dovetail. Of course the half-blind dovetail might be used at the front with the dado construction at the back as in the first type of drawer. It is very important to follow the rule about placing the faces, face sides being turned in so as to make the members of the joints fit face to face.

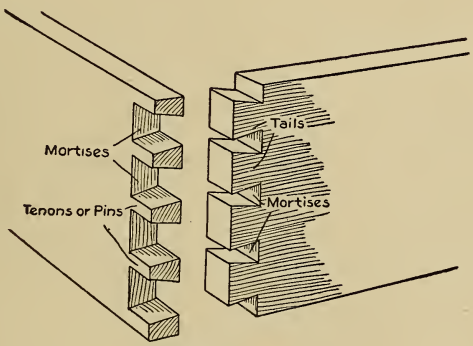


Fig 118—Dovetail Joint

Directions for Making Dovetail Joints

There are no new principles in the layout or working of the corner joints of the ordinary type of drawer. The making of the dovetail joints for the cabinet drawers, however, will require specific directions. The tails, Fig. 118, are to be made on the drawer sides and the pins or tenons on the drawer back. Locate the shoulder lines on the back and front and on the sides at the same time, and square knife lines around in the

usual manner. On the ends of the back and front lay off center lines for the tenons, Fig. 119. Set the bevel square to a slope of 5/8 in. in 3 in. and lay off the flares across the ends. The greatest flare must be at the face side. Carry these lines down the two broad surfaces of the drawer, back as far as the shoulder lines. On the drawer front carry them on the face side only.

Set a gauge to a distance equal to that wanted for

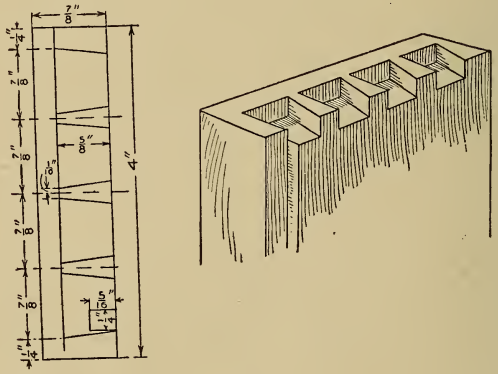


Fig. 119—Front Board Mortise

the length of the tails on the forward ends of the drawer sides or ends, and gauge across both ends of the drawer front, the head of the gauge being held against the face side. With fine cutting tenon or back saw, saw the tenons, keeping the kerf on the waste, of course. With a chisel, and working from both sides, cut the shoulders. Figure 120 shows the manner of sawing and chiseling the blind dovetails.

To make the tails place the tenons upon the drawer sides so that the face side is on the knife line indicating the shoulders and mark the sides as in Fig. 121. With

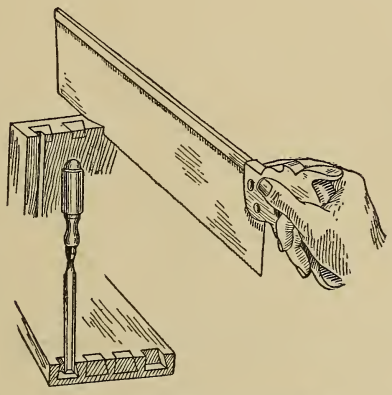


Fig. 120—Sawing the Mortises

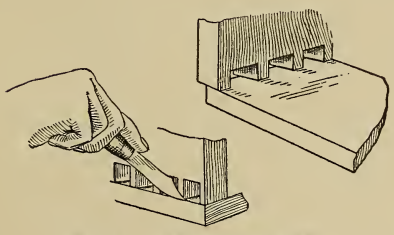


Fig. 121—Marking the Tails

try-square and bevel square complete the layout on the ends and far side. Saw the sides, then chisel the shoulders, chiseling from both sides.

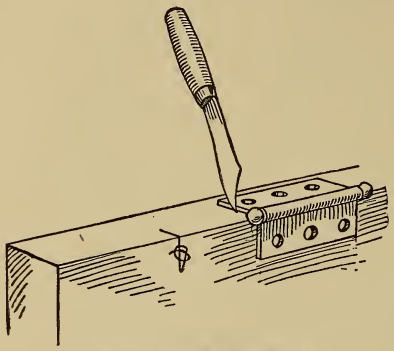


Fig. 122A — Marking Gains

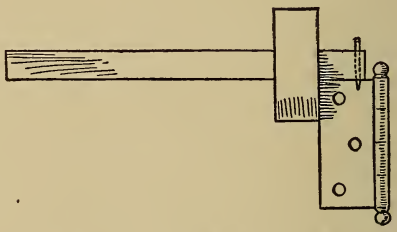


Fig. 122B — Finding Depth of Gain

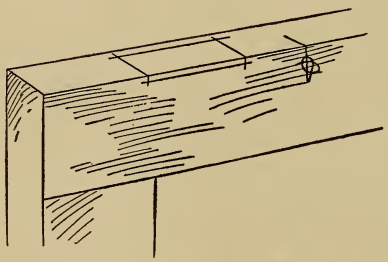


Fig. 122C — Gauged from Face Side

If the parts have been carefully made, it ought to be possible to fit them together with but little trimming. Fit them together dry, bottom and all, to see that all is ready, then glue and clamp. As in the panel, put no glue on the bottom unless a little at the center of the ends. In fitting the bottom, should it prove thicker than the groove, plane the under side of the drawer bottom at the ends. After the glue has set, the joints may be smoothed up and the drawer fitted to its run-

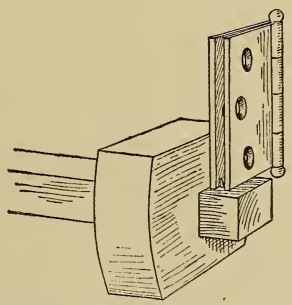


Fig. 122D—Setting Gauge for Depth

way. The pull should be placed, but should be taken off during the application of the finish.

The door of the cabinet is to be fitted and hung while the glue is setting on the drawer joints. Plane one edge and the top of the door until they fit the frame of the cabinet. Secure the width of the opening, top and bottom, and transfer it to the door and connect these marks with a straightedge. Plane to the line, testing occasionally by holding the door against the frame to make sure any irregularities are provided for. That the door may open easily, it should have a little play and the back arrises should be lowered slightly in planing

the edges. Secure the length on each side of the door and plane up the remaining end accordingly. No stop will be necessary except at the top of the door, against which the door can bump, the shelf supports acting as stops.

In hinging the door, place the lower hinge just above the lower rail and the upper hinge just below the upper rail. Place the door against the stops and slip something under it—a chisel or knife will do—to hold it in place, then mark on both door and jamb simultaneously the knife marks for the location of the upper edge of the top hinge and the lower edge of the lower hinge. Take down the door and, holding the hinge as in Fig. 122A, mark the length of the gains. Do this on both door and jamb, making sure to have the two correspond. Set a gauge for the width of the chiseled gain into which the hinge leaf is to enter (Fig. 122B). This distance is to be determined by the thickness of the door and the amount the knuckle is to project. In this case, let the line be gauged within ⅛ in. of the arris, gauging from the face side of course (Fig. 122C). Next set a gauge for the depth the hinge is to be sunk (Fig. 122D). With these settings gauge both door and jamb. In gauging the jambs for the width of gain, it frequently happens that the stops interfere. This can be remedied by having one gauge with its end sawed off very close to the spur. In this cabinet the stops might have been left off until after placing the hinges.

If loose pin butt hinges are to be used, separate the parts and attach one to the door and its remaining leaf to the jamb. If the hinge is what is known as a plain butt, they will have to be attached to either door or jamb and the door held up while the remaining leaves are fastened to the corresponding gains. Put only one or two screws in each leaf until the door has been

put in place and tested. Even with expert mechanics it is necessary to make a trial test. If the hinges bind, that is, if the door cannot be shut without springing the hinges, remove the door and the leaf of the hinge that causes trouble on either jamb or door and insert a piece of cardboard or heavy paper the full length of the hinge and again test. If the hinge in the first test fails to draw the door up against the jamb, it will be necessary to remove the hinge and chisel the gain deeper. Allow a little play for the wood finish, as this will add some thickness and a little additional allowance must be made for swelling, the amount depending upon the size of the door—in this case not more than $\frac{1}{16}$ in. on lock side and top and bottom. Fit the hinge side up practically tight, without forcing. The gains are to be scored and chiseled according to processes previously learned. A comparatively new style of hinge is shown in Fig. 123. It is easily applied. One leaf is gained into the jamb, the door is then placed and the other or surface leaf is screwed to the door while the door is in this position.

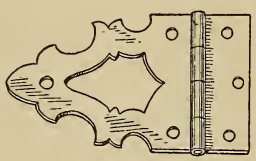


Fig. 123

Directions for Placing Lock

After hinging comes the locking. Figure 124 shows a common form of cabinet lock. The lock is attached by first locating a hole for the key and knob at a point somewhat above the center. Hold the lock against the stile and mark through the box and press the key pin against the stile. The lock is to be let into the stile so that the holes will need to be bored back from the edge of the stile far enough to allow the selvage

to rest slightly below the surface of the edge of the stile about $\frac{1}{32}$ in. This is to allow for planing the door, should future unlooked for swelling necessitate. Again place the lock against the stile and mark off the length of the gain for the selvage. Gauge for the

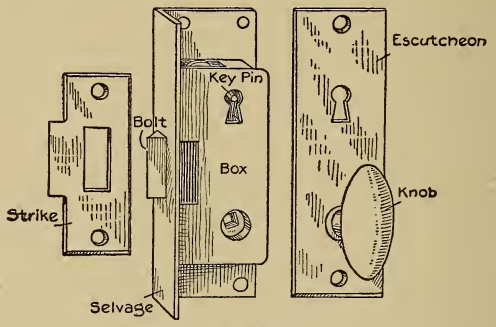


Fig. 124—A Cabinet Lock

depth and width of the selvage and chisel, after scoring, in the usual manner. Next chisel just enough to let in the box of the lock and the face. Place the screws. Swing the door in place and turn out the bolt and mark its vertical position on the edge of the jamb. Square these lines back on the jamb and after securing the horizontal measurement from the door, transfer it to the jamb and mark the near side of the small mortise which is to hold the bolt when the door is locked. Place the strike and knife around it and then chisel the mortise carefully. Screw the strike fast and chisel out enough to let the bolt enter it.

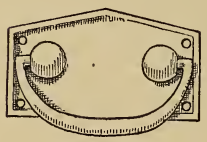


Fig 125

Figure 125 shows a drawer pull. The manner of setting it is easily seen.

Directions for Shelving

The shelving is to be made next. While the drawing shows but two shelves, there may be any number desired. There are various ways of holding movable shelving in use among cabinet workers. The simplest is a metal fixture so made that it slips into one of a

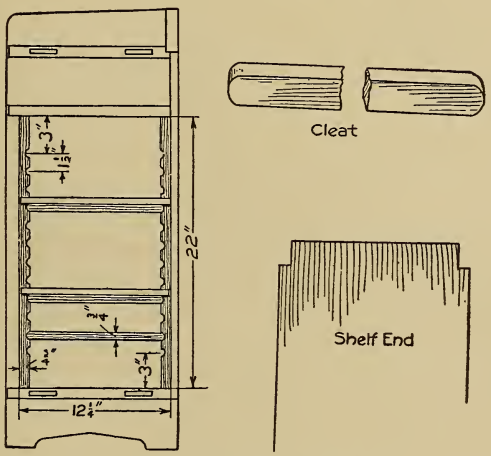


Fig. 126—Shelving Details

series of holes bored in the sides of the cabinet at each of the four corners. These holes are uniformly spaced and allow the shelves to be placed in many different spacings. Small dowels would answer the same purpose. Figure 126 illustrates another and more substantial method. For this, square up two pieces of ¼ or ⅜-in. stock to a width of 1½ in. Gauge a line down the middle and lay off on this holes 1½ in.

apart, beginning about 2 or 3 in. from the bottom. Bore ¾-in. holes at these centers and rip along the gauge line. Plane off the saw marks, saw the pieces to length and nail them one in each corner of the cabinet. Make twice as many cleats as there are to be shelves, rounding the ends after having determined the length by measuring the cabinet. The width of these cleats will need to be ¾ in. and the thickness the same as the corner supports. These cleats can

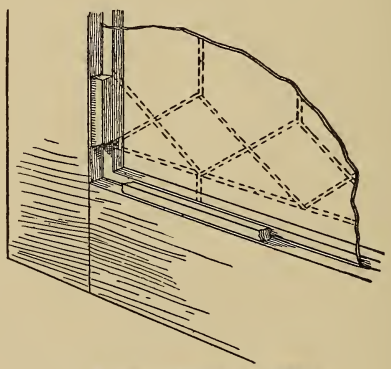


Fig. 127—Setting the Glass

be placed in any desired location. Square up the shelves and with try-square, gauge and saw lay out and notch the ends so that their ends will rest upon the cleats.

Directions for Setting Glass

There remains the making of the fillet which is to hold the ornamental glass in the frame of the door. This may be made square. Make it in one piece, then miter and fit it after the glass is set. Before setting

the glass the cabinet should be scraped, sandpapered and made ready for the finish. The stain and filler should be applied, then the glass set. In setting this glass, place a cushion of putty in the rabbet first, then place the glass in the rabbet, pressing it firmly into the putty. Put another layer of putty on the glass and place the fillet of wood on this. Fasten the fillet in place, Fig. 127, with small brads and putty the holes made with putty colored to match the filler.

OUR OTHER PUBLICATIONS

SHOP NOTES SERIES OF YEAR BOOKS

One of these books is issued the first of each year, and is a reprint of all articles which have been published during the year past in our "Shop Notes Department."

SHOP NOTES FOR 1905
200 Pages. 385 Illustrations.

SHOP NOTES FOR 1906
228 Pages. 555 Illustrations.

SHOP NOTES FOR 1907
228 Pages. 580 Illustrations.

SHOP NOTES FOR 1908
212 Pages. 536 Illustrations.

SHOP NOTES FOR 1909
216 Pages. 561 Illustrations.

SHOP NOTES FOR 1910
224 Pages. 543 Illustrations.

SHOP NOTES FOR 1911
224 Pages. 468 Illustrations.

These books are a perfect gold mine of information for everyone interested in mechanics, or who uses tools for pleasure or as an occupation. Of equal value and help to the professional mechanic and the amateur. Size 6½x9½ inches. Paper cover.

Sold singly at 50 cents per volume or Set of Seven Volumes in Case, $3.50, prepaid.

AMATEUR MECHANICS No. 1

A 100 page book for old and young telling how to make scores of useful articles. The descriptions and illustrations enable anyone mechanically inclined to build at trifling expense all sorts of things for the home as well as for use in outdoor sports. 165 illustrations.

Size 6½x9½ inches. Price 25 cents, postpaid.

AMATEUR MECHANICS No. 2

Contains entirely different matter from No. 1, yet along the same interesting, practical lines. Tells how to make many more useful articles. Interesting to the practical mind. 128 pages, 193 articles, 196 illustrations.

Size 6½x9½ inches. Price 25 cents, postpaid.

MECHANICS FOR YOUNG AMERICA

NEW REVISED EDITION

Tells how to build boats, tents, windmills, water-wheels, electric burglar alarms, clocks, searchlights, water motors and scores of other mechanical devices which delight the heart of the average boy. 128 pages. 200 illustrations.

Size 6½x9½ inches. Price 25 cents, postpaid.

POPULAR MECHANICS CO., Chicago

50c

A Book for which there is a Real Need

50c

Practical Mechanical Drawing

For individual study, shop classes, trade or high schools and those who would like to know something of the drafting profession.

By WM. F. WILLARD

Formerly Instructor in Mechanical Drawing at Armour Institute of Technology, Chicago

134 Pages 131 Illustrations Price 50c

Size 5x7 Inches Cloth Cover

CHAPTERS ARE DEVOTED TO:

1. Simple Geometric Exercises and their Application.
2. Theory of Projections.
3. Working Drawings and Exercises.
4. Drafting Room Conventions.
5. Development of Patterns.
6. Penetrations and Developments for Sheet Metal Workers and Tinsmiths.
7. Value of Isometric Drawings.
8. Vocabulary of Technical Terms with Definitions.
9. Equipment and Its Use.
10. A Model Course for High Schools.

SENT POSTPAID TO ANY ADDRESS BY THE PUBLISHERS

POPULAR MECHANICS CO., Chicago

MR. PATTERN-MAKER!

BE A MASTER OF YOUR TRADE

Our new book, just from the press, will help you to this end

Pattern-Making

By G. H. WILLARD

With Additional Chapters on

Core-Making and Molding

224 PAGES 312 ILLUSTRATIONS CLOTH COVERS

"Written So You Can Understand It"

Price, $1.00 Postpaid

A book for the man who has to do the work. Written by a practical pattern-maker of many years' experience. Gets right down to business in the first chapter and keeps it up throughout the book. Full of kinks and actual working information. Profusely illustrated.

Chapter Headings

I. Pattern-Making as a Trade. II. The Tools. III. Woods. IV. Joints. V. Turning. VI. Turning (Continued). VII. Turning (Continued). VIII. Turning (Concluded). IX. The Circular Saw. X. The Circular Saw (Continued). XI. Machine Tools. XII. Machine Tools (Continued). XIII. Simple Patterns. XIV. Simple Patterns (Continued). XV. Simple Patterns (Concluded). XVI. Crooked Patterns. XVII. Large Pattern Work. XVIII. Large Pattern Work (Continued). XIX. Crosshead Guide Patterns. XX. Sweep Work. XXI. Pipe Work. XXII. Stove Pattern Work. XXIII. Molding—Machine Work. XXIV. Molding Pattern Work.

Part II—Core Making and Molding

Chapter I. Core-Making, Simple and Complex. II. Principles in Molding. III. Loam Patterns and Loam Molds.

Everyone following this trade, or intending to learn it, should have a copy of this valuable book.

Published by

POPULAR MECHANICS CO., Chicago

A NEW BOOK THAT IS NEEDED

Power Gas and the Gas Producer

By J. C. MILLER, M. E.

An Authentic Text Book and a Complete Reference Manual Covering Every Detail of Installation and Operation

The new method of adapting the latent power in coal to man's best use is still a mystery even to the well informed, because nearly all the literature on the subject has been written under the assumption that the reader knows as much about the subject as the writer. A comprehensive treatise, clear of abstruse technicalities, in every way authentic, yet

"Written So You Can Understand It"

has therefore been needed for some time. Such is the book just published. Condensed summary of contents:

Producer Gas—The Gas Producer—Chemistry of Producer Gas—Classes of Gas Producers—The Anthracite Producer—The Suction Producer—The Down-Blast Producer—Industrial Gases—Nitrogen—Natural Gas—Blast-Furnace Gas—Water Gas—Heat Values—Government Experiments—The Siemens Producer—The Wile Producer—The Smith Producer—The Taylor Gas Produder—The Loomis-Pettibone Producer—The Morgan Gas Producer—Gas Producer Fuels—Use of Peat for Gas Producer Fuel—Lignite—Heat Loss in Steam Plant Compared with a Gas Producer Plant—Water Required in Gas Producer Plant—Cost of Repairs—Present Standing of Producer Gas—Producer Gas for Furnace Work—Stand-by Losses—Heat in the Engine—Cooling Water—Gas Holder—Noise Produced by Gas Engines—The Gas Producer and the Smoke Problem—Producer Troubles—The Operator for the Gas Power Plant—Objections Urged Against the Gas Producer—Reliability of Gas Power—Compressed Air for Starting—The Gas Producer from the Insurance Standpoint—Capacity of the Gas Producer—Time Required to Start a Gas Producer Plant—Adaptation to Specific Use—Engines Should be Adapted to Fuel Used—The Erection of the Producer Plant—Building for a Gas Producer—Producer Casing—The Testing of Producer Gas—Starting a Gas Producer in Operation—Efficiency of a 500-Hp. Plant—Comparative Cost of Steam and Producer Gas Installation—Tables, Diagrams, etc., etc.

Printed on the best quality of book paper, profusely illustrated with halftones from photographs, diagrams, etc., and durably bound in extra cloth

Price $1.00 Sent postpaid to any address **200 Pages**

POPULAR MECHANICS CO., Publishers

CHICAGO

MAY 10 1911

One copy del. to Cat. Div.

MAY 10 1911

LIBRARY OF CONGRESS
0 013 971 648 6